

A Manual of
TROPICAL CITRUS CULTURE

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A Manual of
TROPICAL CITRUS
CULTURE
(SECOND ENGLISH EDITION)

By

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with an introduction by

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THIS BOOK IS DEDICATED TO THE MEMORY OF
SIR WM. C. TWYNAM, K.C.M.G.
WHO STARTED CITRUS GROWING AMONG THE PEOPLE
OF THE NORTHERN PROVINCE, CEYLON
— SOME FIFTY YEARS AGO

FOREWORD TO SECOND EDITION

THERE is in Ceylon very little literature on fruit growing other than the Agricultural Department articles and bulletins, and a book on the subject of citrus cultivation in particular is readily welcomed.

The first edition of Mr. Stephenson's book issued a short time ago is already exhausted, and the present edition has been considerably supplemented by the inclusion of new chapters dealing with the cultivation of the Lime, the Passion Fruit and some very useful information on the propagation of citrus. Chapter eighteen deals in fact with what is initially the main point in successful citrus propagation -- the varieties that ensure compatibility in the grafted plant -- very useful indeed is this to the grower who intends to raise his own requirements. This second edition will therefore be appreciated by all interested in citrus fruit growing and who are desirous of establishing or improving their present fruit areas.

The book is intended mainly for growers or prospective growers of citrus in the mid-country regions of the Island, but many of the principles apply generally to citrus growing elsewhere also. The citrus industry holds promise of a bright future and Mr. Stephenson having achieved a measure of practical success in his orchard has, on his own initiative and with a deal of spadework and energy, presented to the public the fruits of his practical experience and interest in the subject.

It is hoped and believed that his enterprise will be rewarded in an increase of citrus production and on lines more advanced than that of earlier days.

T. H. PARSONS,
Curator, Royal Botanic Gardens,
Peradeniya.

March 13th 1942.

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AUTHOR'S PREFACE AND ACKNOWLEDGMENTS

This manual is an attempt on the part of the writer to place before the general public interested in tropical citrus cultivation, a simple, direct statement in non-technical language of what in his opinion is best calculated to be of practical utility. Instead of going into moot points he has, after a fairly wide reading and collation of the competent authorities backed by his own practical experience, preferred to indicate simple, practical and at the same time up-to-date solutions of and advice on the problems confronting the local cultivator. He knows how widespread is the interest in citrus and he feels that any helping hand given will not be unwelcome.

He would like to acknowledge with many thanks the assistance and advice both in theory and practice given by the members of The Ceylon Agricultural Dept. on their many visits to The Uva Orange Farm, and whose literature on the subjects concerned has been freely quoted. (*See Bibliography.*)

The writer would like to mention his particular indebtedness to :—

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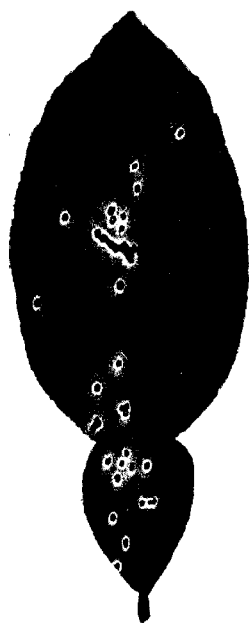
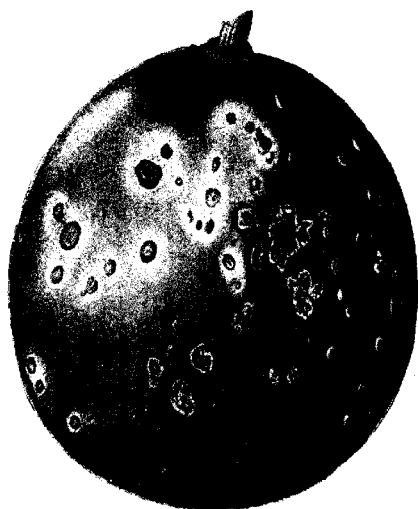
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Diyatalawa,
September, 1940.

For the photographs which illustrate the Second
English Edition the author is indebted to the skilful
craftsmanship of Mr. B. G. Thornley, A.R.P.S.

Diyatalawa,
January, 1942.



(See page 40)

CITRUS CANKER

(Block by Survey Dept.)

INTRODUCTORY

CHAPTER ONE

Introductory

The term *Citrus* is a wide one covering amongst the other varieties the grapefruit, the orange, lemon, the lime fruit, the mandarin or tangerine, the citron and the pummelo. In structure citrus fruits are composed of carpels, that is, separate sections each of which is filled with tiny juice sacks. Botanists tell us that these carpels or sections result from a whorl of transformed leaves.

Of these the **Orange**, whose botanical name is *Citrus sinensis*, is the most popular and most widely grown. The sweet orange is grown in most parts of Ceylon, but in the hot and humid Low-Country there results a thick-skinned fruit, green in colour and lacking in flavour. The most favourable conditions would seem to be those obtaining in the Mid-Country, with elevations of from two to four thousand feet.

The name **Grapefruit**, *Citrus paradisi* as the botanists call it, comes apparently from the fact that the fruits grow in clusters not unlike bunches of grapes. As a general rule Low to Mid-Country districts are most suitable for grapefruit cultivation which would seem to call for a certain modicum of shelter. At elevations of more than 4,500 feet grapefruit would not seem to be a paying proposition.

A well drained piece of land facing the south, slightly sloping and sheltered from strong winds,

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is the **ideal site** for a citrus plantation. In districts with a heavy rainfall, sloping ground is essential to afford a good runoff and to allow a free drainage. Citrus plants do not like wet feet, yet a certain amount of moisture in the soil is essential for their well being; at times semi-irrigation is necessary to produce a paying crop of a reasonable size.

Soil. A free sandy loam with a good humus content may be said to be the most suitable soil for citrus. The best citrus is grown on a limestone subsoil. A soil analysis may be useful to determine certain facts about the soil in which citrus is grown, especially where abnormal conditions are apparent. Unfortunately soil analysis is not the exact science it is generally believed to be; it will give the exact percentage of the elements present but cannot tell how far these are available to the tree. There may be many different kinds of soil in a ten-acre block, and when one realises that an acre foot of soil weighs some 2,000 tons per acre it is apparent when one takes a sample weighing about a pound that it is very difficult to get a true representation of this enormous weight. The tree itself is a true indicator of soil conditions. To be worth while, soil analysis work should be done by Chemists of the highest standing, and done periodically for purposes of comparison and as an indication of the response to different methods of cultivation and the improvement of soil conditions.

The cost of opening an Orchard. This depends on many factors: on the price paid for the land, the cost of supply of water for irrigation and the cost of the imported plants. Where virgin

INTRODUCTORY

jungle is planted and water has to be pumped for irrigation, the cost of bringing a citrus plantation into bearing will not differ appreciably from that of the same area planted in tea.

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CHAPTER TWO

Contour Terracing - Drainage - Roads - Method of Planting - Fencing

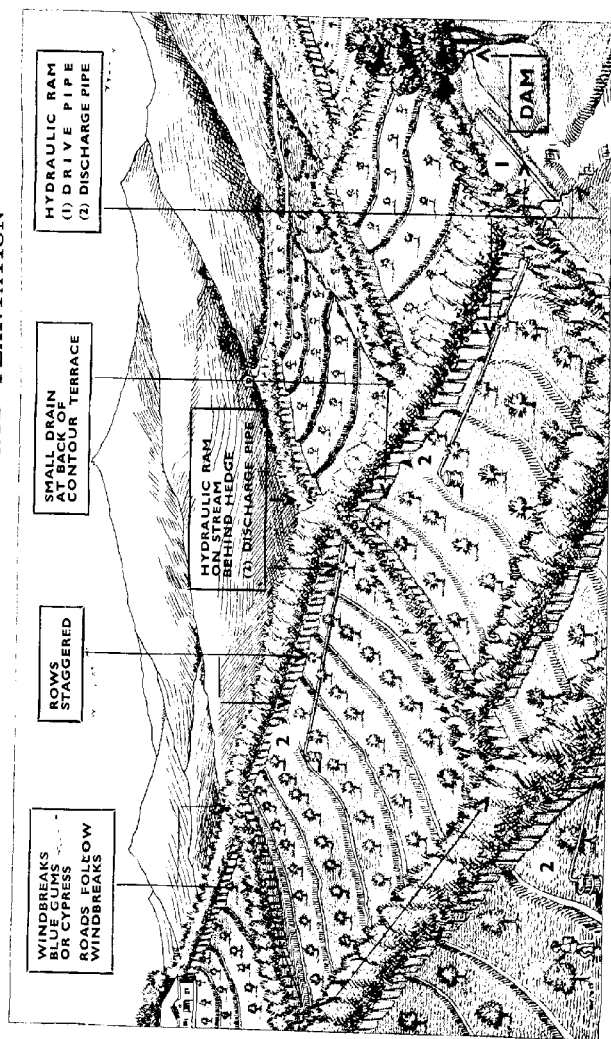
Terracing. What follows in this section takes it for granted that the citrus plantation is in the ideal zone indicated in Chapter I *i.e.*, in Mid-Country, and enjoying the ideal sloping conditions. These latter conditions call for guidance in the construction of terraces.

It is recommended to plant orange plants twenty feet apart.

Terraces should be cut to allow a minimum width of 12 feet or more if the lie of the land allows. The backward gradient should be 1 : 10. It is advisable to peg out the terrace formation and then cut with a common road tracer. A longitudinal slope of 1 : 120 is advisable to prevent a bursting of the walls from heavy rainfall, by giving a runoff which will serve later for irrigation.

When opening up Patna land, an 18 inch digging fork is useful to dig the large deep sods which should be built into a rough retaining wall. This wall when finished should be 12 inches above the finished level of earth that has been filled in. In course of time and after due weathering this containing wall will subside considerably but even after settling down there will be sufficient height to give the required inward slope.

LAYOUT OF YOUNG CITRUS PLANTATION



Note WINDBREAKS.—If the Windbreaks are Blue Gums the foliage should be allowed to come nearer the ground level than shown in the sketch. If Cypress is used it can be clipped to ground level to form a hedge.

TERRACING AND PLANTING

Drainage. A small drain should be cut along the inner edge of each terrace to connect with a main drain so that each terrace has an outlet for flood water at roughly every 200 yards. Roads should drain into these main drains via a short length of terrace, if necessary.

The main drains should have silt pits cut in them at intervals of approximately 20 feet or at closer intervals if the lie of the land calls for them. A handy size for silt pits is four feet by two feet, in addition to the section of the drain being dealt with. It is recommended that the pits be cut at or near the junction of the terraces with the main drains so the earth that has been washed down can be returned with ease to the terraces when the pits are being cleaned out.

Roads. These should be allowed for at intervals of 60 feet or at every third terrace. The average gradient should be kept to 1 : 18. The width should be about 5 feet but scope for widening later to 9 feet if possible should be allowed for.

Planting. Having got the terraces at least 12 feet wide, the hole sites for planting may be spaced out with a 20-foot rod. The ideal measurement for these holes is 3 feet \times 3 feet \times 2 feet deep. They should be in a line about two-thirds of the distance from the inner edge of the terrace to the foot of the retaining wall. This arrangement allows for free drainage. In practice it will be found that the roots tend to run towards the inner solid earth.

It is preferable to stagger the rows of trees and not to line them; this tends to break the wind

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which would otherwise form draughts between the rows.

The holes should be filled with good black earth, leaf mould and a generous sackful of well rotted horse or cow manure. Every effort should be made to prepare the holes at least three months before planting time. A fortnight before the plants arrive four large, double handfuls of slaked lime should be added to each hole. This may be left an inch or so below the surface of the filled hole. When filling holes, the earth filled in should be piled up to a height of 8 inches to 10 inches above the level of the surrounding ground to allow for settlement later.

When actually planting, the crown of the graft should be fully 3 inches above the piled-up earth, and whatever the weather, each should be given immediately one large bucket of water. Imported grafts may be soaked in a bucket of water for 10 minutes before planting. This soaking can easily be overdone : ten minutes is enough.

The growers usually recommend that the trees be wrapped and loosely tied to keep the sun from drying the stems. Large plant protection baskets of some 24 inches in height and 10 to 12 inches in diameter are recommended as they keep the ground moist as well.

Fencing. Concrete or angle iron posts of at least seven feet above ground are recommended : in the case of the former barbed wire may be fixed with the aid of large split pins. These fences if planted with Passion fruit will pay for their erection in a short space of time. The posts

TERRACING AND PLANTING

should be spaced at 8-foot intervals as the passion fruit vine is a heavy one: otherwise 10-foot intervals will suffice. Long posts should be allowed for here and there where the lie of the land calls for them.

Table showing Number of Trees
per Acre according to Spacing

Distance Apart	Number of Trees	Distance Apart	Number of Trees
24 Feet	75	18 Feet	134
22 "	90	17 "	150
20 "	100	16 "	169
19 "	120		

Note:—When setting out holes, try and give Lemons and Mandarins a position where irrigation is possible. They are both apt to develop Chlorosis when young, in very dry places.

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CHAPTER THREE

The best known varieties - The Ceylon Orange - Where to get good plants

The Orange

The two best known varieties of Sweet Orange are the Washington Navel and the Valencia Late.

The Washington Navel, an orange sent to Washington from Bahia, Brazil, is a sport or freak variety of the **Selecta**, a Portuguese orange. Growers sought trees of the navel variety and from the success of the orange developed the present Washington Navel. This was as far back as 1873.

In California, the Washington Navel orange ripens in the Autumn and Winter, being picked from November to May. The fruit is quite round and of a deep golden colour. It is distinguished from all other oranges by the navel formation at the end opposite to the stem, the formation having the appearance of a very small orange within the larger one.

Another peculiarity of the Washington Navel orange is that it is seedless, an advantage which causes many people to prefer it to all others.

The Californian Valencia Late orange is supposed to have originated in the Azores. It ripens from April until November in California.

VARIETIES OF CITRUS

The fruit is lighter in colour than the Navel, but more oblong in shape and without the navel formation at the end.

It is not entirely seedless but the few seeds it contains is one of its outstanding points. The fruit does not ripen for a year after flowering, and bloom and ripe fruit may be sometimes seen on the same tree. The juice of the Valencia orange is slightly more acid than the Navel, making a wonderful orange squash.

Other useful varieties. Next to the Valencia Late orange, comes the **Jaffa** orange: both these oranges are said to be resistant to Citrus Canker which is common in Ceylon. This question of canker will be dealt with at length later (see Chapter VII).

The Jaffa Orange, due to its peculiar shape which makes it hard to pack, is not popular with professional growers. The fruit is elongated but of excellent quality and flavour. It is said to be a hardy variety, and is extensively grown in Palestine. The South African improved variety of Jaffa Orange bears a round fruit and has developed into a drought-resisting plant, and is more upright in growth. It is an early fruiting variety.

The Brazilian Orange (the **Pera** variety) is a very popular one in America but one learns little of it from the Californian literature on Citrus. It is a sweet-juiced fruit of excellent flavour, slightly smaller in size than any of those already mentioned. As the climates of Brazil and Ceylon are somewhat the same it should do well in Ceylon.

The Mediterranean Sweet Orange is an early cropper and on a rough lemon stock

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does well in the upper parts of Uva. The fruit is of excellent flavour and rather sweeter than the Navel, but smaller in size. Unfortunately it is very subject to canker. There are several other kinds of orange including the **Malta Blood** orange, **St. Michael's**, etc.

Ceylon Oranges. There are several strains of Local orange grown in the Low-Country of Ceylon, the better known of which are :

(1) **The Cotta Orange.** This is a small green-skinned fruit, but a prolific cropper.

(2) **The Vavuniya Sweet Orange** is a variety which bears a fine, good-sized, juicy fruit, and is vigorous in growth.

(3) **The Local Sweet** propagated by Peradeniya Gardens has many outstanding qualities, and is a hardy, strong growing plant bearing a good-sized fruit.

(4) **The Amunapura Orange** is a prolific bearer of superior quality.

(5) **The Middeniya Orange** is another: it bears a smaller fruit of good quality.

(6) **The Moneragalla District** has been noted for its oranges since the middle ages. The ancient Sinhalese Kings are said to have got their fruit from this district. Some of the wild oranges are still to be found in the depths of the Moneragalla Jungles. This little known district is one of the biggest orange producing centres in Ceylon. It grows a very superior Local Lime large in size and thinner skinned than the common lime of the Low-country.



ORANGE NAVELENCIA

Imported South African graft planted November, 1940

*(Photographed May, 1941
Uva Orange Farm)*

VARIETIES OF CITRUS

The Lemon

The lemon is known to botanists as *Citrus limonum*: it is an egg-shaped fruit, yellow in colour and acid in flavour. The foliage is lighter in colour than the Orange although it is evergreen. The trees grow to a height of over 20 feet and a single tree in California has been known to produce 3,000 fruits in a year. The lemon requires a somewhat warmer home than the orange.

The **Eureka** is one of the best known varieties, almost entirely free of thorns. The **Lisbon**, **Genoa** and **Villa Franca** follow in close order.

The young **Lisbon** Lemons are vigorous and upright in growth with many large thorns. The leaves are usually narrower and more pointed than the **Eureka** variety.

The Lime

The lime is more prone to fungoid disease and should have special attention. Good drainage is essential as well as heavy manuring, and a mulch when just coming into flower. Protection from winds is particularly necessary. Its botanical name is *Citrus aurantifolia*. The lime likes a sandy or free soil but requires irrigation to give of its best. It thrives up to a level of 3,000 ft.

The **Tahitian** or **Seedless Lime** is strongly recommended as a hardy, good cropper, and as its name implies is seedless and bears a bigger fruit than the local varieties.

Another variety is the **British Guiana Lime**.

(*The Lime is dealt with in detail in Chapters XI and XII.*)

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The Mandarin

The Indian Nagpur, sometimes called an orange, would appear to suit Ceylon Low-Country conditions either in wet or dry zones. In the latter it requires irrigation. It is of the loose-skinned variety and is a good cropper.

The Mandarin Emperor and **Beauty of Ghent** are also good kinds. Of the subtropical varieties of Mandarin, the **Dancy** is extensively grown in California. The **Beauty of Glen Retreat** is recommended as a variety to be grown at higher elevations in Ceylon.

The African Naartje is known as a drought resister: the fruit is smaller in size than those before mentioned.

The Grapefruit

The Grapefruit is grown more successfully in the Low and Mid-Country districts of Ceylon, as a moist heat is as a general rule necessary. Grapefruit likes a sheltered pocket to thrive in.

Marsh's Seedless stands first: it is a robust heavy cropper and, as its name implies, seedless or almost so. The other varieties include **Walter's**, **Macarthy's** and **Pernambuco**. **Walter's** is supposed to be an earlier bearer, and the **Triumph** variety of Grapefruit is a good one.

Selection of Trees

The best is good enough. A good rule to follow in buying trees is to go to a reputable firm, as one does for any other article. In selecting trees, both the budstock and the rootstock are of primary importance. (*Chapter XVIII deals specially with Rootstocks, Scions and Budwood.*)

VARIETIES OF CITRUS

There are several sources of good plants ; grafts of some three years old can be obtained from Messrs. Pickstone & Bro. Ltd., P.O. Simondium, Cape of Good Hope. These grafts are of excellent quality and suited to local conditions, as their home is subject to prolonged droughts. They arrive well packed and are handled by a reliable Colombo Firm who despatch them on the day of their arrival in the Island.

India as a Source of Citrus Grafts. Excellent grafts grown at a suitable elevation may be obtained through the Hony. Secretary, Punjab Fruit Development Board, Punjab, Lyallpur. There are several well known firms in Upper India who specialise in Citrus work and supply good plants.

Another source is Australia, where several large nurseries export named varieties of Citrus. The plants, however, do not appear to be such robust ones as their brethren from South Africa.

The fact of using imported plants ensures that they are initially more or less immune from Citrus canker. One must not overlook the fact, however, that canker is almost universal in Ceylon, and one's orchard has every possibility of infection sooner or later.

Canker can be controlled, if not cured, if taken in hand when plants are young. A case in point is the Government Experimental Station at Bibile which at one time was badly infected. Now it is almost free of citrus canker. We cannot yet say, of course, whether cases of canker will recur or not.

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CHAPTER FOUR

Irrigation - Fertilising and Green Manure

Irrigation. The object of irrigation is to replace the water removed from the soil by the crops; there is the further object of carrying soluble fertilizing materials into the area of the roots. Nothing is gained by wetting soil which has no roots in it; the most efficient irrigation wets only that portion of the soil which has become dry through the activity of the roots. Most of the roots should be in the first 14 inches of the soil but this should be investigated.

Ideal irrigation consists of wetting the soil thoroughly for 24 hours once a fortnight in dry spells, but irrigation is essential just before the trees come into flower.

The water should be led at the back of the terraces or at least five or six feet away from the trees where terracing has not been done and allowed to gradually seep up to the root area.

Discretion must be used in the question of irrigation and it should not be done when the ground is already sufficiently moist.

It is seldom that pumping has to be resorted to under local conditions, but when this becomes necessary the cheapest way of doing it is by Hydraulic Ram, provided that a head of water exists at a lower level in quantities sufficient for the Ram drive.

IRRIGATION AND FERTILISING

A Ram is a simple machine for pumping by water power. It is automatic in operation and once installed it goes on working continuously pumping water without further expense except the occasional renewal of a worn part. A spring flowing at the rate of a few gallons per minute is sufficient to work a Hydraulic Ram provided that there is a fall of 10 to 15 feet; it will pump approximately one-seventh of the drive water five times the height of the head on the drive pipe. A fall of 15 feet with the given length of drive pipe recommended by the makers will pump against a head of 75 feet.

As a general rule the drive pipe should be six times as long as the fall is high. The discharge pipe may be a size bigger than that recommended by the makers; this is to reduce friction.

Fertilising. The question resolves itself into terms of Humus and Nitrogen.

Humus or vegetable mould is necessary for both light sandy soils and heavy soils, for the former to hold the irrigation water, for the latter to help in opening up the soil so that it can take water and permit easy growth. In both cases humus furnishes 'beds' for the propagation of bacteria without which fertilisers fail.

Humus is available in many forms such as rough bedding manures, cover crops, the straw of the soya bean, since this has been acclimatised in Ceylon, lucerne or alfalfa, dead leaves, etc.

Green Manures. The subject is a much discussed one. One school of thought is entirely

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against green manure for citrus. The reasons given are that it denudes the soil of the lesser manurial ingredients *i.e.*, phosphates and potash at the expense of the citrus plant ; and although the green manure produces a certain amount of extra nitrates, the digging in is apt to damage the small roots of the citrus. In drought areas cover crops use up much water. A safe course to adopt, if short of mulching materials when planting seedlings, is to plant a cover crop well away from the young citrus plants and this when mature can be cut and mulched around them. Soil conservation we have already allowed for by contour terracing. Any farm-yard manure must be buried, otherwise a lot of the ammonia it contains will be lost.

Artificials. The necessity of **Zinc** as a fertiliser aid to lusty trees and good crops has been proved during the last few years. Zinc combined with sulphur is dusted on the tree. See Chapter VIII which deals with the most recent developments in the use of Zinc in Citrus Culture.

Plant Hormones seem to form the chief subject of modern research in relation to citrus manures in America.

The low percentage of the three well known plant foods in animal manures, and the resulting growth after application under favourable conditions tend to point to the presence of some further plant stimulant which scientists are at present investigating. The parts played by the minor elements have been pretty well thrashed out, and it now remains to prove that it is the plant hormones which are mainly responsible for the results obtained.

IRRIGATION AND FERTILISING

Certain composts, and particularly leaf-mould, contain a trace of Vitamin B1. The inter-relation of vitamins and hormones is being investigated by The American Department of Agriculture at present.

Everything seems to point to the **importance** of a liberal dressing of good animal manure at least once yearly as an insurance against manurial deficiencies which may be found to occur if artificials only are applied to citrus trees. In tropical countries compost is easy to make and if included in the manuring programme in addition to the animal manure, you won't go far wrong.

Let it be again emphasised that for economic citriculture experimental manurial plots *are a necessity*, and should be laid out under expert advice. **In matters of manuring always consult an expert.** The Ceylon Agricultural Department never fails in giving excellent advice when required, and will inspect your plantation if asked to do so.

Moderately Acid Soil required for citrus. Chemists grade soils according to their acidity or alkalinity on the pH scale which is as follows:—

<u>Grade of Soil</u>	<u>pH Value</u>
Very alkaline	9
Alkaline	8.5
Moderately alkaline	8
Slightly alkaline	7.5
Neutral	7
Slightly acid	6.5
Moderately acid	6
Acid	5.5
Very acid	5

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Some citrus soils go as high as 9 to 9.5 on this scale but 6 to 6.5, or even 7, has been found to be the ideal, and in all cases an effort to reduce the pH Value below 8 is desirable.

For reducing alkalinity **Sulphur** is one of the best allies. Organic matter of all kinds is another valuable source of acid. **Gypsum**, sulphate of lime, is approximately neutral. **Nitrolim**, crude calcium-cyanamide, is moderately alkaline and may be found to suit local conditions, but see that it is not lumpy as then it loses more than half its manurial value. A guaranteed analysis is a necessary item when buying artificial manure. American figures show the actual removal of the following manurial ingredients from an acre after a heavy crop of oranges :

54 lbs. Nitrogen,
14 lbs. Phosphoric acid,
56 lbs. Potash,
22 lbs. Lime.

A deficiency of **Manganese** in some soils has a marked effect on citrus plants especially as regards growth; the injurious effect of a lack of **Iron Salts** is a serious matter where expert opinion should be called in; both these soil deficiencies lead to chlorosis which is akin to anaemia in the human body. The application of small quantities of **Magnesium Sulphate** can be experimented with for sickly plants. **Boron** is another element which common boric acid powder will supply; a boron deficiency shows up in the foliage of the plants, which has a yellow streak in it and inclined to be spotty; in fact it is called spotted leaf.

IRRIGATION AND FERTILISING

Another aspect of the foregoing paragraph: all these chlorotic conditions may be brought about by a lack of soil moisture without which the elements though present cannot be absorbed or utilised. One is apt to neglect this important view of the situation. In dry districts try a good watering twice per week, and if conditions do not commence to improve in, say a fortnight, call in an expert to advise on the necessary treatment.

It will be noticed that **Potash** is absorbed in large quantities by the citrus tree. It is a known fact that potash stimulates those enzymes which aid the transference of starch in the plant. Experiments are being conducted at present to ascertain whether heavy potash applications affect the sweetness of the fruit. The chemical change of starch into sugar being a simple one, this piece of research may yield results which will have a far-reaching effect on future fertilising of citrus. Lime liberates potash when applied to the soil.

All Patna Soils are sour and acid and the presence of a sufficient quantity of **Lime** to render them neutral and keep them so is essential: a yearly application of one lb. per year of growth per tree up to 10 lbs. as recommended by Dr. A. W. R. Joachim, Agricultural Chemist, Peradeniya, is not too much. Note that no manure either artificial or natural should be applied within a month of this dressing of lime. Lime is best applied on the surface of the soil and lightly raked in, it has both mechanical and physical effects, and citrus cannot be successfully grown without its presence in the soil. An effective form

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of lime is "Dolomite" lime which is combined with magnesium and appears to suit the citrus plant better than the common coral lime. Some soils are deficient in boron, some in magnesium, zinc, etc.; this can be determined by experiment; apply small quantities of each and watch results carefully.

When buying artificial manures compare their guaranteed analysis; look into the matter of cost per unit of each essential constituent and use this as a guide in buying. Go to a reputable firm of manure merchants.

One of the most economical mixtures of artificial manures is :

5 parts of Niciphos (two)

3 parts of Sulphate of Potash.

This mixture contains all the ingredients that a good tonic should have. It has the advantage that it can be mixed without fear of losing any of its essentials; thus it can be applied in one operation. The amount is approximately a cigarette-tin-full per plant up to one year; increase this amount by half for each year of growth. Apply around the plant over the whole root-spread and lightly rake in.

Control Plots. Before exclusively applying any to your plantation you must, for purposes of comparison, have a control plot where none of these manurial ingredients has been applied. If on sloping ground, see that your control plot is on a higher elevation. A few experimental plots carefully worked are better than any amount of soil analysis. The analyst can tell you what the soil contains but he cannot inform you whether the ingredients that are present are in such a

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form that the plant can make use of them. You can do this for yourself without any fee by a simple system of manurial experimental plots.

Animal Manure. The strongest form of animal manure is fowl manure and if you have some sickly trees a light dressing of it works wonders. Horse manure is particularly suitable for citrus; the better the ration the horse eats the better the manure. Cow manure locally is not what the good old English Farm Yard Manure represents, *i.e.*, the animals if not fed on a good ration of oilcake etc., cannot produce the manurial value that the term F.Y.M. represents. Should this be allowed to weather out in the open, as generally happens, most of its manurial ingredients are lost. If fresh manure is buried for a period of say a month preferably, where one is about to plant something, its valuable ingredients are conserved. You can liken the average soil to a sponge that will absorb anything that is buried in it.

One of the most valuable parts of manure is the humus it contains. After a yearly dressing of animal manure is applied, we must consider what tonics the tree requires; these should be given in the form of artificial manures. Their application is most economical if they are applied after heavy rain or after a period of irrigation. One may ask oneself why after irrigation? The answer is, should you have a heavy fall of rain unexpectedly, most of the valuable manure might be lost and find its way into the drains. If applied before irrigating, some of the manure may be leached away from the roots; this frequently occurs in the lighter soils.

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Mulches. In the cultivation of citrus the soil requires constant loosening to make it more retentive of moisture and give it the necessary aeration. A mulch is essential in dry windy weather; this may consist of any green stuff but should be, if possible, from a leguminous source which contains a valuable nitrogenous content. All leguminous plants have a pod, and obtain their nitrogen from the air, through small nodules in their roots.

A good Mulch-cum-Compost for drought areas, which has been made and applied with much success on the Uva Uplands, is made from leaves, garden rubbish, hedge clippings, etc., mixed with 10% kitchen rubbish and wood ashes, 10% earth and 40% coir dust. In order to break this down quickly add a cwt. of Hyperphosphate per half ton.

Compressed coir dust can be got locally from J. H. Vavasseur & Co., Ltd., at a very reasonable price, in a form which renders transport an easy matter. A. Baur & Co., Ltd., supply the hyperphosphate well bagged in cooly loads without extra charge.

Where kitchen rubbish is unobtainable the product from the local village incinerator makes a good substitute and is well worth the cost of transport. Watering is necessary, and the compost should be turned once or twice to expedite breaking-down process. Pits should not exceed 20 inches in depth to ensure presence of soil bacteria.

FERTILISER MIXING CHART

Although the preparation of fertiliser mixtures is generally better done by reliable fertiliser mixing firms than on the estate where facilities for intimate and even mixing are seldom available, it is sometimes necessary to do a certain amount of mixing with stocks of fertilisers left on hand, and this chart shows in a clearer manner than has hitherto been devised what may and may not be mixed.

Where Nitrogen and Phosphoric Acid alone are required in the fertiliser, the modern compound fertilisers such as Niefos are safe, convenient, cheap, and highly efficient, and the Nitrogen and Phosphoric Acid in them are much more evenly and closely associated than is possible in any mechanical mixture.

Its use is perfectly simple and straightforward. Supposing one wishes to mix Sulphate of Ammonia, Sulphate of Potash and Superphosphate, all that is necessary is to run the finger along the line beginning with the words SULPHATE OF AMMONIA in the horizontal list of fertilisers and consult the spaces on that line under the other two fertilisers in the vertical list*. It will be seen, in the example given, that in both cases the space contains the figure "0" which means that the mixture can safely be made. If Slag had been chosen instead of Superphosphate, the symbol "X" would be noted in the space beneath it, showing that the mixture cannot be made without loss of valuable properties. If Potash Salts were to be included in the mixture instead of Sulphate of Potash, it will be observed that the sign "◇" appears in the appropriate space. This means that the mixture can be made provided that it is spread on the day of mixing.

In exactly the same way, starting with any one ingredient of a proposed compound, the mixing qualities or otherwise of the remainder may be determined.

0—May be Mixed. ◇—May be mixed if applied quickly. X—Should not be mixed.										
NOTE.—Dry conditions of Mixing are presumed in this chart.										
* Except dissolved bones which should be treated as Superphosphate.										
	Sulphate of Ammonia	Nitro-Chalk	Nitrate of Soda	Calcium Cyanamide	Sulphate & Muriate of Potash	Potash Salts & Kainit	Superphosphate	Basic Slag	Bone & Rock Phosphates*	Niefos, Lemnaphos, Diammonphos
Sulphate of Ammonia	0	0	0	X	0	◇	0	X	0	◇
Nitro-Chalk	0	0	0	X	◇	◇	◇	X	0	0
Nitrate of Soda	0	0	0	0	◇	◇	◇	0	◇	0
Calcium Cyanamide	X	X	0	0	0	◇	X	0	0	0
Sulphate & Muriate of Potash	0	0	0	0	0	◇	0	0	0	0
Potash Salts & Kainit	◇	◇	◇	◇	◇	0	◇	◇	◇	◇
Superphosphate	0	◇	◇	X	0	◇	0	X	◇	◇
Basic Slag	X	X	0	0	0	◇	0	0	X	0
Bone & Rock Phosphates*	0	0	0	0	0	◇	0	0	0	0
Niefos, Lemnaphos, Diammonphos	0	◇	◇	X	0	◇	0	X	◇	◇
Carbonate of Lime	◇	0	0	0	0	◇	0	0	◇	0
Oxide of Lime	X	X	0	0	0	◇	X	0	0	0

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WINDBREAKS

CHAPTER FIVE

Windbreaks

Need of Windbreaks. Orange trees, in fact all citrus plants, are very sensitive to wind. I quote some figures from American Orchards to prove this :

Average total return \$ 229.64 per acre — Wind-break provided.

Average total return \$ 137.68 per acre — No windbreak.

Windbreaks should not be planted within 20 feet of any fruit tree.

Windbreak Protection. Windbreaks should be provided at frequent intervals, say not less than a 100 feet apart where strong winds are experienced. At elevations of 2,000 feet and over, **Cypress**, *Cupressus macrocarpa*, makes an excellent windbreak.

(a) **Cypress** Windbreaks should be planted in rows six feet apart to form a rough hedge. Cypress likes a deep trench, preferably filled with a mixture of earth and kitchen rubbish, at least four feet wide by two feet deep. This may sound expensive but it pays to do the young trees well. The wind protection should precede planting by at least six months.

Cypress is prone to attacks of white ants and continues to be subject to their attacks for some years. A good dressing of wood ash at regular intervals would tend to stop this. This should

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not be applied in very dry weather ; after rain is the best time. After a few months the trees can be clipped into a hedge and any casualties replaced at once. Basket trees are recommended as Cypress does not transplant well.

(b) **Blue Gums.** An alternative is a double row of Blue Gums but these should be frequently topped to make the lower branches furnish sufficient growth to form a windbreak.

Gums and cypress when first planted require frequent watering in dry weather to induce quick growth. A dressing of lime is beneficial especially on acid soils such as patna land.

(c) **Lattice-work Fences.** In America lattice-work high fences are erected ; there is more in this than meets the naked eye. These fences can be planted with Passion Fruit vines which soon cover them completely. The fruit has a ready market and will soon pay for the somewhat costly erection.

Where virgin jungle is felled for planting, the timber is easily come by, and if the portion of the tree which is inserted in the ground and for about one foot above the ground level is charred, the fence will stand for many a year. A rough lattice of the lesser branches stayed by the forked ones placed to support the structure, keeps it from being blown over during gales and has the double advantage of making an excellent windbreak and at the same time proving a paying proposition.

The advantages of lattice breaks are that they give immediate protection, there is no waste of land, and they help to raise a paying crop. (*See Chapter XVII on Passion Fruit Culture.*)

PEST CONTROL

CHAPTER SIX

Pest Control

Pests are one of the principal limiting factors of profit in orange growing, in fact in any citrus enterprise. The treatment consists in killing living insects with as little damage as possible to the tree itself.

Difficulties of the problem. The problem is a difficult one, as each district may differ as regards its major pests. A wet zone for instance differs from a dry district in the species of insect to be dealt with, and the incidence of attack will vary at different times and seasons. Not only has this to be taken into consideration in a spraying programme, but there is the further fact that two or more insects have to be catered for, and the double duty carried out in one operation.

America's tackling of the problem. In America this pest control has developed into a fine art and in addition to spraying, dusting, etc., systems of fumigation are carried out by pest control experts. The following is a condensed extract from a booklet recommending Fumigation for Scale Insects in particular.

"Liquid Hydrocyanic Acid Gas Fumigation." Applied under tents by experts, this is one of the most effective methods of eradicating scale. The gas is a quick deadly poison, and should give 100% kill of scale. The vaporisers give a rapid dispersion of the gas and secure uniform results.

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Red, black and citricola scale are readily killed by this treatment, and it has given wonderful results, but it is a dangerous practice if not handled by experienced operators. It is possible to damage the tree and a careful skilled fumigation is required.

Care should be taken not to use hydrocyanic acid gas within a year of any application of copper sulphate or Bordeaux Mixture.

Mature fruit should not be treated with it.

Oil Spraying as carried out in America consists of the use of highly purified petroleum of 90% unsulphonated residues, which is an index of purity. They are sold under certain classifications based on the oil distillation percentage at 636 degrees Fahrenheit.

Light 65 - 80, light medium 52 - 62, medium 40 - 49, heavy medium 28 - 37, and heavy 10 - 25.

The light is used for **Red Spider** control when scale has already been treated. The light medium is used for **black scale** and **citricola**, and the heavy medium and heavy oils for **red scale**.

These oil sprays kill by contact of the oil film with the insects, probably by closing their breathing tubes. The oils used do not readily evaporate and are probably absorbed by the leaves, bark and fruit, therefore one should be certain that organic poisons do not form part of the mixture. On the other hand, for young seedlings and newly planted grafts, a stomach poison such as a lead arsenate solution has to be used for caterpillars which, if left uncontrolled, can completely defoliate the young plants in the course of a few days.



Typical Oil Spraying Unit engaged in
pest control in a Texas grove



Lemon terminals showing scarring, "rat-tailing" and
rosette type of growth caused by citrus thrips

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There are various forms of patent sprays such as Sulphinette, Sulsol, Busiol, etc., some of which contain colloidal sulphur and copper sulphate; of these the first mentioned is the cheapest.

In spraying one should see that the under surface of the leaves gets a full share of the spray, since sprays must actually cover the pest being sprayed for; the spray must cover the whole tree thoroughly.

The use of Nicotine Sulphate. When trees are young any of the proprietary sprays such as Sulsol or Sulphinette, mixed as the makers recommend, combined with Nicotine Sulphate, forms a good prophylactic. The last mentioned ingredient is mixed at the rate of one oz. per gallon when using a 5% Nicotine Sulphate solution and *pro rata* for stronger solutions. Nicotine Sulphate is an expensive item, but if ordinary chewing tobacco is taken and boiled down overnight, with an oz. or two of lime, a good substitute is obtained though not quite as effective as the commercial Nicotine Sulphate. Nicotine Sulphate is not toxic to the tree.

Spraying Machines. There are various spraying machines on the market. The writer has found the Solo, a one man spray, reasonable in price and efficient in action. Spraying should be done on a dull day if possible or at least during the late afternoon or evening when the sun is not too hot, otherwise burning of the leaves will result. Discretion must be used as to when to spray: a good maxim is "Spray all young growth."

Sulphur dusting. Citrus plants suffering from *Oidium* may be treated with flowers of sulphur dust or, if this cannot be readily applied, with

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sulphinette spray. Oil sprays should be avoided within 40 days of sulphur dusting. Trees in flower should not be sprayed nor should overmature fruit be treated if it can be avoided.

The best time for sulphur dusting is when dew is on the foliage; if applied during the heat of the day the sulphur may burn young fruit and foliage. This dusting is excellent for the control of **thrips** and **yellow mite**. The citrus thrips has a tiny light yellow body; it feeds on tender growth and young oranges and leaves a scar and does much damage to young foliage. A sulphur spray can be used where dusting cannot be done.

Oil emulsions. In addition to these oil sprays there are oil emulsions used in various forms. Here in Ceylon we use a fish-oil made in India, termed **Kerala**. This is most effective for scale and black mould and comparatively inexpensive; it will tackle aphids as well, if a strong mixture is made up.

Citricola scale can be treated with Kerala. It is a mottled grey, oblong scale of medium size. In America it occurs yearly; here in Ceylon it appears to be always with us.

Citrus Aphides, or plant lice, are soft grey to black insects; they suck the juices from the young leaves and cause them to roll up from the tips. Nicotine spray or dusting is the remedy.

Black scale can be recognised by the ridges on its back, shaped like the letter H. It robs the tree of sap and it also develops large amounts of honey dew which is soon converted into a sooty mass by fungus growths. An oil spray

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eradicates it. Kerala is quite successful.

Cottony cushion scale is controlled in America by the introduction of the **Vedalia Lady Bird beetle**. It has a waxy covering which renders it hard to treat. **Mealybug**, *Citrophilus*, is controlled by a parasite. Here an oil spray is the best treatment available. Ants which help these scales can be killed with a syrup containing arsenic.

Fruit-fly. This pest is one of the worst enemies of the Citrus industry. We make no apology for incorporating Dr. Hutson's excellent paper on fruit-fly almost *in toto*.

"Fruit-fly can be controlled if one takes the trouble to carry out a proper campaign to combat it. It should be borne in mind that the bagging of fruit kills two birds with one stone -- prevents damage by fruit-fly and Canker spots on the fruit as well.

"The females of the citrus and mango fruit-fly usually start laying eggs in fruits, such as oranges, grapefruit, mangoes, &c., just before these begin to ripen. The eggs are laid inside the fruit and hatch within one week into maggots which tunnel about inside the fruit, causing it to decay and sometimes to drop early. The maggots are full-grown in 1 to 2 weeks and come out of the fruit, drop to the ground and form their puparia or cocoons about 2 inches below the surface. Maggots emerging from fallen fruit usually pupate in the soil under or near the fruit. The pupal stage lasts about 1 to 2 weeks, after which the male and female flies come out of the soil in approximately equal numbers. The female flies may remain for

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at least one month after emergence before laying their eggs and, since they require food before mating and egg-laying, they can frequently be attracted to feed on a sweetened poisoned bait and be killed before they can lay their eggs.

“This pest is usually present in considerable numbers in any citrus or mango plantation during the fruiting seasons, but the flies themselves frequently pass unnoticed, and the presence of the pest is not usually detected until much damage has been done and the fruit has begun to fall prematurely or turn rotten on the trees as the result of maggot infestation. By that time it is usually too late to start a control campaign with any real prospect of success and nothing can be done beyond the regular collection and destruction of fallen fruit.

“These notes are intended to show that this fruit-fly can be satisfactorily controlled and that most of the crop in a garden or orchard can be saved if the suggested control campaign is started in good time and carried out thoroughly and systematically. It will be noted that (1) citronella oil is a very useful indicator of the seasonal prevalence of this fruit-fly; (2) that a sweetened poisoned bait can be used to the best advantage during the seasons of prevalence; (3) that bagging of half to two-thirds grown fruits serves to protect them from subsequent attacks of fruit-flies to a great extent, but does nothing towards reducing the numbers of these flies; and (4) that the systematic collection and suitable disposal of all fallen fruits are essential to the success of any other control measures employed.

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1. Citronella Oil Lure

(for *males* of the citrus and mango fruit-fly)

“Experiments have shown that the ordinary commercial citronella oil is quite attractive to *male* flies of the citrus and mango fruit-fly (*Dacus ferrugineus*) when exposed in glass jam-jars two-thirds full of water with about 10 drops of the oil on the water. The jar can be hung on the branch of a tree by an arrangement of wires and the jar-cover or a cigarette tin cover should be suspended about two inches above the jar to keep out heavy rains. The water and oil should be renewed twice a week during dry weather and once a week during wet weather and the catch of flies counted. The *males* of the citrus fruit-fly are small, dark-brown insects, a little larger than house flies, with black and yellow bands and stripes on the body and a pair of clear wings. Occasionally a few other flies and other smaller or larger insects may be attracted to the citronella jars, but the fruit-flies can soon be distinguished. The type of tin recommended for poisoned bait can also be used for the citronella oil lure without the cloths, but may not be quite so effective as the glass jars.

“Since citronella oil does not attract the egg-laying *female* flies, it has no special value as a control measure for this pest. This oil when exposed in jars of water does, however, serve as an indicator that the pest is present in an orchard or garden, since it is known that both *male* and *female* flies of this species may be present at about the same times of the year and in approximately equal numbers.

“It may be mentioned that the vanilla essence,

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ammonia and water lure recommended in Australia has not proved attractive to our fruit-flies.

“In order to find out whether the citrus fruit-fly is present in a fruit area it is necessary to expose two or three citronella lure jars on trees as soon as the earlier fruits are about half-grown. When the number of *male* fruit-flies per jar rises to about a dozen or more in two or three successive weeks, then it is usually advisable to start using the poisoned bait according to the instructions given.

“There may be two periods during the year when fruit-flies are unusually numerous, that is, a major and a minor season of prevalence, and these usually occur when citrus or mango trees or both are in fruit. These two periods of prevalence may vary somewhat according to the district, and fruit growers can obtain this information for their own districts by the use of the citronella lure jars during the early part of the fruiting seasons. For instance, at Peradeniya there is a minor season of fruit-fly prevalence during February and March, coinciding more or less with the secondary fruiting season of citrus and with the mango fruiting season. This is followed by a decline in numbers of flies during April and May. Then there is another marked rise in numbers to the major season of prevalence from June to August coinciding approximately with the main fruiting season of citrus.

2. Poisoned Bait

(for both sexes of the fruit-fly)

“Poisoned bait can be used to the best advantage during the periods when fruit-flies are likely to be

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most numerous, that is, mainly during the fruiting seasons of citrus and mango. If citronella jars have not been used, then baiting should be started about six weeks before the earlier fruits are expected to ripen and carried on throughout the season. It is generally unnecessary to use it at other times of the year.

“The following is the formula for making the bait :—

<i>Either</i> sodium silicofluoride powder		
<i>or</i> lead arsenate powder	..	2 oz.
Cheap sugar	..	2 lb.
Water	..	4 gallons.

“The same proportions can be used for larger or smaller quantities. Mix the powder with a little water and stir this into the sweetened water made by dissolving the sugar. Sodium silicofluoride is a non-arsenical powder, but if it is not available the lead arsenate can be used as a substitute, but it is more expensive.

“*Bait tins.*—The liquid poisoned bait can be exposed in cigarette tins specially prepared for the purpose. Six vertical cuts about one inch deep are made at intervals in the top edge of each tin and alternate pieces between the cuts are bent outwards to form three horizontal flaps; the tin is covered to keep out rain and wires are inserted into the pieces between the flaps so that the tin can be hung on to a branch. Each tin is supplied with about 3 oz. of the bait and small strips of cloth or lamp-wick are placed with one end in the liquid and the other end projecting slightly beyond the edge of each flap. The flies come to feed on the wet clothes and then fly away to die elsewhere

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so that no dead flies will be found in the tins, as in the case of the citronella lure.

"Only about 24 trees per acre need be baited at one time, using one tin per tree, and it is estimated that about 4 pints of bait will be required per acre for each application, using about 3 oz. of liquid per tin. The bait tins should be renewed periodically when they become too rusty inside and the liquid can be replenished as required. The exposure of the poisoned bait in tins ensures that the flies have continuous access to the poison, whereas the liquid dries up fairly soon when sprinkled in large drops and may lose some of its effectiveness or be washed off by rain. If an orchard is known to be heavily infested with fruit-fly, it is advisable to bait one-third of the area with tins and to sprinkle at least another one-third periodically in rotation for the first two or three weeks after starting the treatment ; a less intensive programme can be carried on thereafter.

"Sprinkling.—The same poisoned bait can be applied to the trees with an ordinary garden syringe and the liquid can be squirted into the air so as to fall on the leaves in large drops, and while applying the liquid the operator can walk round the tree. If a syringe is not available, the bait can be sprinkled on to the leaves with a bunch of twigs or a broom. If sprinkling of the tree is considered undesirable, bunches of twigs or bundles of paddy straw can be hung on the trees and sprinkled with the bait. The bait should be used two or three times a week during the early part of the season and once a week later on, if the flies are being controlled. It should be applied during the late afternoon in fine weather

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and repeated after heavy rain.

“It is usually necessary to sprinkle only about one-third of the trees in rotation in any given area, or about 24 trees in an acre of about 70 trees. For each application by sprinkling, one pint of the liquid bait will treat 3 or 4 trees in full bearing, so that this amount will be sufficient for a small garden of about one dozen trees. About one gallon will be required per acre for each application. As regards costs, it is estimated that, using sodium silicofluoride, one gallon of the bait will cost about 7 cents, while with lead arsenate as the poison the cost per gallon will be about 10 cents. One acre can therefore be treated for about 10 cents per application for cost of materials alone. Lead arsenate costs about Rs. 1.50 per lb. and sodium silicofluoride about 50 cents per lb. at Cargills, Colombo, and the cost of freight will have to be added.

“The following poisoned bait programme is suggested for an orange grove of ten acres situated in a dry zone district, assuming that the fruiting season starts at the beginning of December and lasts for about four months until the end of March.

“The poisoned bait should be started about six weeks before the first fruits are expected to ripen and should be continued for about five months, that is, the baiting season should extend from about the middle of October until about the middle of March. During the first three months, which are likely to be wet, it is preferable to expose the bait in the tins, so as to protect it as far as possible from heavy rains, and to employ the sprinkling method of application during the

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last two months, which are normally dry. Advantage can, however, be taken of any dry periods during the monsoon to sprinkle the bait instead of using the tins or to combine the two methods in a more intensive baiting programme.

“Approximate cost of baiting in tins.—It has been explained previously that about 24 tins will be needed per acre, or 240 tins for ten acres; also that about 4 pints of bait will be required per acre for each application, or about 5 gallons for ten acres per application. During a tin-baiting season of three months, 24 applications will be necessary at two applications per week, so that 120 gallons of bait will be required for the ten acres for three months. As regards labour, two men for half a day at 30 cents each can renew the bait in 240 tins, costing 60 cents per application, or Rs. 14/40 for the 24 applications during the three months. The following will be the approximate cost for ten acres :—

	Rs. c.
240 tins cut and fitted with wire at 4 cents per tin	9 60
One renewal of 240 tins using old wire at 3 cents per tin	7 20
120 gallons of bait at 7 cents per gallon ..	8 40
Labour for 24 applications at 60 cents a time	14 40
	39 60

The cost of baiting 240 tins for the three months is therefore Rs. 4/- per acre.

“Approximate cost of sprinkling.—The bait can be applied for two months during dry weather, and 16 applications will be required at two per week, using one gallon per acre or ten gallons for

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the whole area per application at 7 cents per gallon. If the liquid bait is sprinkled on to bunches of twigs or bundles of straw hung on the trees, no special apparatus will be required, as a bunch of leafy twigs can be used to sprinkle the liquid. Two men for half a day at 30 cents a man can treat the 240 trees, costing 60 cents per application.

	Rs. c.
16 applications over ten acres at 70 cents	
per application ..	11 20
Labour for 16 applications at 60 cents	
a time ..	9 60
	20 80

“The cost of sprinkling 240 trees for the two months is therefore about Rs. 2/- per acre. The total cost of using the two baiting treatments for five months over ten acres will be about Rs. 6/- per acre. The above cost will be increased to nearly Rs. 7/- per acre if lead arsenate has to be used instead of sodium silicofluoride.

“It may be mentioned that the fruit-fly poisoned bait should also be useful in controlling the large fruit-piercing moths which puncture the fruit in order to suck the juice. Punctured fruits turn rotten and drop, and the damage is sometimes mistaken for that caused by fruit-flies. The puncture made by the moth can be seen as a small round hole from which juice oozes freely when the fruit is squeezed, but the egg-laying puncture made by a fruit-fly soon closes up and is not noticeable until a small decaying patch begins to form.

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3. Bagging of Fruits

"In *The Tropical Agriculturist*, February 1936, pp. 100-101, a note appeared on the bagging of grapefruit and it was stated therein that bagging kept the fruit free from fruit-fly attack and from infection by citrus canker. Further trials made on the Experiment Station, Peradeniya, by the Principal, Farm School, Peradeniya, have indicated that bagging of grapefruit has proved to be quite effective in preventing attack by fruit-fly and that unbagged fruit is usually heavily attacked.

"It should be emphasized that bagging alone does not in any way help to control fruit-fly, but merely prevents the flies from laying their eggs in the fruit. Any unbagged fruit is liable to serious infestation. Therefore, if bagging of fruit is employed, it is advisable that other measures, such as the use of poisoned bait and destruction of attacked fruit, should be taken to control fruit-fly.

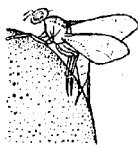
"Usually single fruits are bagged with the smaller size greaseproof paper bag (8" × 10") costing Rs. 7/50 per 1,000 or $\frac{3}{4}$ of 1 cent per bag, and approximately two bags are required for each fruit up to the maturity of the same. The cost per bag, including twine, labour, &c., is estimated at 2½ cents up to the maturity of the fruit. Sometimes it is necessary to include two or three fruits in a larger bag (12" × 14") costing Rs. 10 per 1,000.*

* These prices are based on the pre-war price of greaseproof paper. At the time of printing this edition greaseproof paper, if obtainable at all, can only be got at a price which is prohibitive of its use for bagging fruit.

PEST CONTROL

4. Destruction of Attacked and Fallen Fruit

"If fruit-fly is to be effectively controlled in citrus and mango areas, it is essential that all attacked and fallen fruit should be collected and destroyed from the time that the first attacked fruit is noticed or the first good-sized fruit has fallen. This should be done *daily* throughout the fruiting season as a routine measure whether other control measures are employed or not. If regular collection is started early, the daily number to be destroyed should be very small and easily disposed of. All such fruit should be burnt at once or thrown into a kerosene tin of boiling water, so that all maggots still remaining in the fruits are killed. All maggots which escape destruction will pupate in the soil and emerge later as flies to attack any ripening fruit. Large accumulations of attacked and fallen fruit are not only a prolific source of fruit-fly but cannot be destroyed easily and effectively, and usually the only method available is burial in pits. But burial is not entirely effective, since fruit-flies can emerge through several inches of soil. The systematic and complete destruction of all infested fruit is essential for the success of any other control measures. Therefore all such fruit should be destroyed daily so that it will not accumulate to such an extent as to make its disposal difficult."



Side-view of Fruit-fly ovipositing
(The Magnification is $\times 2$)

TROPICAL CITRUS CULTURE

CHAPTER SEVEN

Diseases of Citrus

The author is indebted to Mr. Malcolm Park, A.R.C.S., Plant Pathologist, Peradeniya, for the following on Citrus Canker.

Citrus Canker may be classed as the worst of these in Ceylon. It crops up in all wet parts of the Island. It has been stamped out in many citrus growing countries and some appear to be immune from it. The anti-Canker campaign in America cost some $2\frac{1}{2}$ million dollars and no recurrence is apparent. South Africa also took it in hand and no canker exists there at present. These preventive measures were undertaken as the market value of fruit bearing canker scars is greatly reduced.

Conditions and manifestations. It is most common locally at lower elevations of the wet zones although the Up-Country districts are infected as well. As a general rule, the heavier the rainfall the greater the incidence of the disease. It survives periods of drought but is more easily controlled in dry parts of the Island. Some species of citrus such as the grapefruit and the lime are more prone to attack than others. Mandarins are immune. Two varieties of the oranges, the **Jaffa** and **Valencia Late**, have a high resistance to infection. Lemons are said to be immune. Sour Orange Pummelo and rough lemon, the chief source of stocks for grafting purposes, are also liable to infection. The **Patharan**, an excellent stock for

DISEASES OF CITRUS

budding on to, is also prone to catch the disease. All these are more readily infected when in the seedling stage. The disease is most common and characteristic on leaves, but it also attacks the fruit, small twigs and branches.

Canker and the caterpillar. The disease is sometimes associated with the common leaf miner caterpillar (*Phyllocnistis Citrella*) and canker spots will be noticed on the leaves attacked by it. The caterpillar gets into the galleries of the leaves of which it eats large portions; it is these that usually get infected with canker and spots occur around them. Once established, canker goes on to infect the adjacent foliage.

The Cause of Canker and the Treatment. The disease is caused by bacterium *Pseudomonas Citri*; these bacteria have so far not been known to attack any other plant outside the citrus family (*Rutaceae*.)

The disease is spread by water and especially so by raindrops as well as by moist soil on the hands, feet or clothing of anyone tending the plants. It is therefore essential to disinfect one's hands after touching any part of an infected tree. Animals and birds also spread the disease.

Canker is commonest where the rainfall is spread evenly throughout the year. It is sometimes necessary to plant new orchards in areas in which it is impossible to ensure freedom from canker. Young infected areas may be controlled to some extent by regular spraying, to stop leaf miner primarily, and by the regular picking off and excision of infected leaves and twigs. Regular

TROPICAL CITRUS CULTURE

and heavy applications of lime tend to disinfect the ground around infected trees. Good and effective windbreaks tend to stop the spores being carried by high winds.

Canker if taken in time and treated as described can be controlled so as to make its presence almost negligible, but regular and expert attention should be given to it to prevent its spread.

In young plants the serious nature of the disease is obvious; leaves badly infected are shed and the assimilating surface of others is reduced while canker spots appear sometimes on stems and girdle the young plant causing its death. *Chlorosis* is induced due to defoliation and the general vitality of the tree is sapped.

Root fungus: nature, manifestations, treatment. It is not prevalent in Ceylon to any marked extent. It operates almost wholly underground affecting both the surface and deeper roots. Very frequently it is not noticed until it is far advanced. Its presence is shown by a general deterioration at the top of the tree and by lack of growth. Expert advice is essential for its treatment. Isolation of infected area and carbon bisulphide treatment is recommended by American growers.

For treatment, scrape the affected part and apply a disinfectant. Potassium permanganate may be used, one teaspoonful to a pint of water.

Shell Bark. This affects only the bark of the lemon tree; its presence is first indicated by a cracking of the bark, usually near the bud union, caused by excessive moisture. This is a fungoid

DISEASES OF CITRUS

disease. Trees budded on Sour Orange rootstock are particularly susceptible.

Scrape, but do not injure, the cambium, as the disease travels upwards; apply a disinfectant.

Brown Rot Gummosis affects the bark, and Lemons are more susceptible than other varieties of citrus. This disease is indicated by copious exudations of Gum. It is generally an indication that some other disease has got busy so that a thorough investigation is necessary where it appears. Its cause is found to be soil-inhabiting fungus identified with those which cause the brown rot of fruits. The cause is generally traced to too deep planting and water lying too near the stems of trees. For treatment, scrape out the infected parts and tar them. Allow for better drainage to keep the soil immediately round plants free from standing water.

Brown Rot. This is characterized by a brownish decay of the fruit. It affects the lower branches, within three feet of the ground. For treatment, spray with Bordeaux Mixture. Treat the ground trunk and lower branches.

Bordeaux Mixture consists of 6 lbs. of copper sulphate, 6 lbs. of lime to 100 gallons of water. In case fumigation is to follow, use 1 lb. copper sulphate, 12 lbs. zinc sulphate and 6 lbs. lime to 100 gallons of water.

Scaly Bark, *Psorosis*. This is often mistaken for *Gummosis*: the first indication is a slight raising of the bark either as small or large scales. Gumming does not usually take place at first. As the disease develops, the gum formation usually, but not always, shows near the cambium

TROPICAL CITRUS CULTURE

region. There is a stippled condition of the leaves by which scaly bark can be identified.

Dry root rot. This is a fungoid disease whose cause is root damage, as a rule due to cutting and breaking of roots resulting from bad cultivation. Treat in the same way as for scaly bark.

Remember that an unusually heavy setting of fruit on a tree, especially if the fruit is rather weak, has that appearance and, if the foliage shows signs of weakness, inspect that tree carefully.

Precautionary Measures.

We may summarize as follows :-
that it is best

(a) that free water should not lie about close to the base of the tree ;

(b) that young trees should have the bud union well above the surface of the ground, and should be planted on a mound of earth to ensure this ;

(c) that irrigation water should only be allowed to get to the base of this mound ;

(d) that injuries to the trunk and roots of trees should be avoided ;

(e) to treat any wounds at once.

ZINC IN CITRUS NUTRITION

CHAPTER EIGHT

Role of Zinc in Citrus tree Nutrition

Discovery of the Importance of Zinc. In the early days citrus growers in California incurred considerable expenditure on manures and fertilizers for the orchard. Organic matter was considered as an essential item on their manurial programme and large applications were made with highly beneficial results. In orchards where barnyard manure was not applied in sufficient quantity the trees developed characteristic symptoms of mottle leaf, which reduced their yield considerably, thereby causing a loss of several million pounds to the growers in the state. With the discovery not very long ago of the curative effect of zinc on mottle leaf, the old ideas on citrus tree fertilization have changed. It is now believed that the beneficial effects of barnyard manure are due chiefly to the nitrogen and the small quantities of zinc it contains and both these constituents are applied at a much lower cost – the nitrogen as a chemical fertilizer to the soil, and zinc as a spray on the foliage.

Disease symptoms which respond to zinc treatment may appear on a variety of trees. On the pecan and the apple the disease, or rather the physiological disorder, is called **rosette**; on the citrus fruits, **mottle leaf**; on the walnut, **yellows**; on tung oil trees, **bronzing**; on grape vine, stone fruit trees and some others, **little leaf**.

Methods of Application. The discovery of the beneficial effect of zinc in the treatment of this

TROPICAL CITRUS CULTURE

physiological disorder was made somewhat independently by four different groups of scientific workers in America between 1931 and 1932. Foremost among them is Chandler's* group in California who found that the rapid recovery of the affected branches of deciduous fruit trees was due to the zinc present as an impurity in the Ferrous Sulphate spray they were trying out. Since that discovery in 1931, affected trees have been successfully cured by the application of Zinc Sulphate direct to the soil, in holes about 3 inches apart in the trunk, and as a spray. The effect of soil application is slow, depending on the fixing power of the soil for zinc. Zinc Sulphate applied into holes has never failed to cure a tree, but it kills a considerable amount of sapwood and is not recommended. Driving Zinc-coated nails is likewise injurious to the bark. It is not effective on citrus trees. Spraying the foliage with a mixture of Zinc Sulphate, Hydrated Lime and water in the proportion of 10 lbs. Zinc Sulphate and 5 lbs. Hydrated Lime in 100 gallons of water with a common spreader is about the most effective remedy for mottle leaf on citrus. Lack of sufficient quantity of lime in the mixture will cause serious injury to the leaves and fruits. In recent years Zinc Oxide applied as a dust with Sulphur has proved more effective and is popular since it can be included in the routine operations connected with pest control. *Zinc in whatever form should not be applied during the heat of the day, i.e. between the hours 9 a.m. and 3 p.m.*

* W. H. Chandler, D. R. Hoagland and P. L. Hibbard on *Little Leaf or Rosette of Fruit Trees*. Proc. American Soc. Horticultural Sci. 28: 556-560, 1932.

ZINC IN CITRUS NUTRITION

Results of Application. Striking results have been obtained by the application of the Zinc Spray mixture. It seems to act as a tonic to the trees. Vigour of growth is induced, the leaves recover their normal healthy green colour and yield of fruit is increased. The discovery has revolutionized traditional ideas on orchard practice and has contributed much towards the prosperity of the fruit grower. To the citrus industry in particular, which was threatened with disaster by the alarmingly high incidence of mottle leaf, the discovery has been a great asset. It has meant the gain of several million dollars.

Note :—The foregoing is quoted from American experience only. It should be used with caution until we are sure that local conditions are suited to its application.

(The Author)

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CHAPTER NINE

Pruning and Cultivation

During the last few years the results of several authentic tests of pruning have been announced in America. These results raise the question whether citrus pruning is to be recommended.

It would seem that too much pruning has been done in the past, especially as regards oranges. Pruning requires a careful hand and a competent workman. Trim out dead wood, cut out crossed limbs, suckers, or bend them into branches if they occur in favourable spots on the tree. Remember that money is being constantly spent on water and fertilisers to produce new growth. Leaves are the lungs and food factors of the tree ; through them the tree breathes ; they manufacture certain starches and sugars which are essential plant foods.

The wood growth of a tree falls into three classes viz. the vegetative growth, the sucker growth, and the fruit growth. Vegetative growth is vigorous and upright, with large leaves far apart on the branch, and usually bears fruit on the end. Sucker growth needs no description ; bend it into a branch position if possible. Do as little cutting as possible. Remember the greatest reason for sucker growth is too severe pruning. Suckers are caused by a rapid change of conditions or environment.

Do not get the top of the tree out of proportion with the roots. Fruit wood is the small leaved,



GENOA LEMON

Imported South African graft on rough lemon stock planted November, 1938
(Photographed May, 1941
Cva Orange Farm)

PRUNING AND CULTIVATION

fine stemmed, slow-growing branches upon which even early in their life the evidence of bark may be seen. These usually bear fruit early and continue to bear as they put out new growth. This wood is the strong growth of the tree and therefore capable of supporting a heavy weight of fruit. Bare wood after pruning should be whitewashed; this eliminates sunburn and rot. Non-corrosive paint may also be used or common tar.

Cultivation. American thought on the cultivation of citrus is quoted as follows. Only cultivate when necessary for weed control; leave the plants severely alone especially when in flower. Use the disc harrow before irrigation. Where we experience heavy rainfall locally a certain amount of cultivation is necessary but should not be overdone. The surface of the ground may be broken and kept loose with the mammoth fork which only penetrates a few inches, but further than removing weeds this may disturb the young roots in the immediate vicinity of the tree and should not be carried out when near flowering. In dry districts the surface soil should be kept loose to break up the capillary tubes which exude moisture and tend to dry the ground underneath. Constant aeration of the soil is encouraged by the rain penetrating into it; it takes the air with it. Cultivate only when there is a reason for it. Do not allow a pan in the soil to form, i.e., a hard layer a few inches below the surface.

PICKING NAVEL ORANGES.—The Navel Orange should be picked when it attains a deep yellow hue; the fruit is best picked before midday.

Seize the fruit in the left hand, which should be in a woollen glove of heavy texture, turn the orange with an upward motion of the hand so that the calyx or button comes to a horizontal position. Then clip the stem at approximately $1/32''$ from the button.

When placed in the picking sacks see that it is not bruised in any way or even allowed to drop on to the contents of the sack.

The infinite care used during picking operations is repaid by the keeping quality, and later is reflected in the market price.

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CHAPTER TEN

Production

Tree charts. A system of tree charts is very necessary; this can be done on squared paper and is easily workable.

This telltale diagram may be kept thus :—

* good tree ;	‡ replacement ;
† fair tree ;	§ poor tree ;
	¶ tree out ;

etc., as suits the grower.

If this chart can be kept up-to-date one can see at a glance how things go. Graph paper can be easily obtained and can be mounted on a board and hung up in the office.

The young trees should not be allowed to bear more than a half dozen fruits or so when commencing to bear. If they flower when very young it may be taken to indicate that there is something wrong and the bloom should be rubbed off, and investigation should proceed to find out what is the matter.

Regular intervals should be worked out for spraying and a proper programme of work prepared for field operations.

The gathering of fruit should be done with clippers. Pickers are given gauge rings for the sizes of fruit. It is of the utmost importance that the fruit should not be bruised or damaged



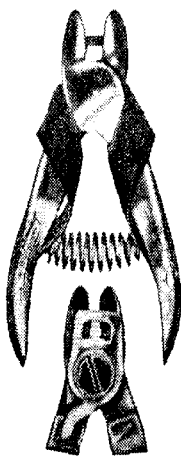
ORANGE VALENCIA

Imported South African graft planted November, 1938

(Photographed May, 1941)

PRODUCTION

and it should be placed in boxes or trays at each tree to ensure that no damage occurs. The sorting of fruit in the packing shed should be done on padded benches with a rim around them to prevent the oranges dropping off and thus becoming bruised or damaged. The keeping qualities of the fruit largely depend on this. The usual practice of bagging fruit which is carried out locally is entirely wrong according to American expert opinion, or if judged by the method practised in Palestine or other large orange growing countries.



A well known Californian Clipper
(Marketed by the Harvey Machine
Co., Los Angeles, California.)

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The Preparation of the Orange for Market (as practised in America.) The fruit is first thoroughly washed with water containing soap suds. Next it is brushed well and is immersed in a solution of hot water 96 degrees Fahrenheit, containing one part of borax and two parts of boric acid, say a 5% solution. After this the fruit is dried in the sun. The chemical solution tends to close the pores of the fruit and prevent loss of weight. Next comes the grading when the small fruit is taken out. In America no fruit is allowed to be marketed which will pass through a 2½" ring.

Sizes of Citrus Packages

T Y P E	Inside dimensions in inches	Capacity in c. inches
Florida Orange Box	12 × 12 × 24	3,456
do Tangerine Box	6 × 12 × 24	1,728
California Orange Box	11½ × 11½ × 24	3,174
do Lemon Box	10 × 13 × 25	3,250
do Jumbo Lemon Box	11½ × 13½ × 25	3,754
Italian Lemon Box	10½ × 13½ × 25	3,544

Specifications for Orange Boxes can be got from the United States Dept. of Agriculture, Bureau of Agricultural Economics, also Grades and Standards on which the American Citrus Crop is handled.

Right time to pick for Artificial Ripening. The fruit should be just beginning to turn yellow before being picked for ripening.

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Lemons may be ripened by placing the fruit loosely in a box for six weeks. The box should be covered and maintained at a temperature as near 75 degrees Fahrenheit as possible with a humidity of 85%. A saucer of water will roughly ensure this.

A well kept diary for the plantation is invaluable.

Obtain the valuable leaflets issued at cost price by the Department of Agriculture, Peradeniya. Get a standard work on grafting; it has not been dealt with here as it is expert work, best done by those who thoroughly understand it; to such persons it should be left. This pays in the end. However, to ensure that it is being properly carried out, study a standard work.

Indian Publications. The publications of the Punjab Fruit Development Board, Lyallpur, (India) contain invaluable information regarding practically all the fruit-growing countries in the Near East, Palestine, Egypt, etc., as well as very full notes on the Italian Orchards. They are copiously illustrated and well written. S. S. S. Lal Singh, B.Sc. (Hons.) M.Sc. California, the Fruit Specialist to the Government, Punjab, and Hony. Secretary, Punjab Fruit Development Board, Lyallpur (India) is well known all over the world. He has visited and reported on all the better known Citrus growing countries, and we are indebted to his reports for several useful pieces of information embodied in this little book.

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CHAPTER ELEVEN

Limes

The Lime, Lemon and Citron are all closely related members of the Citrus family.

Citrus Aurantifolia. The Lime which is grown as a source of Citric Acid and for use in a fresh condition is *Citrus Aurantifolia*. It is cultivated to a great extent in the West Indies. The tree is described as probably indigenous to the wild valleys of the outer Himalayas and probably also to the mountain tracts of the Central Provinces and of Central India.

In this connection it appears that the Lime is a more distinctly tropical plant than Oranges and Lemons, and that in many localities where these latter fruits flourish, temperatures are experienced which are so low as to be inimical to Limes.

Limes were introduced into the West Indies in the latter part of the sixteenth century by the Spaniards, and into the French Colony of Martinique.

Varieties of Limes. The spineless variety of the West Indies is the most commonly grown out there. However, in Eastern countries where citrus canker is rife, the **Tahitian** or **Seedless Lime** is gaining in popularity, chiefly due to its resistance to citrus canker, and because of its larger fruit. It is hardy as well as being a good cropper. The

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British Guiana Lime is also a popular variety; it bears a more acid fruit than the Seedless Lime, but is liable to develop canker very easily.

Lands suitable for Lime Cultivation. Gently undulating land is regarded as the best for lime cultivation; free drainage is essential, with ample protection from high winds. A free loam can be described as most suitable for the lime, preferably land which was in jungle; again it is stressed that free drainage is necessary because the lime is more prone to fungoid disease than other citrus varieties. Heavy manuring is required, especially when the plants are young.

In the East the Lime thrives up to a level of about 3,000 ft. elevation. When choosing a site for a lime plantation in dry zones, it should be borne in mind that a certain amount of irrigation will be necessary for economic fruit production.

Windbreaks. (*See also Chapter V.*) If Limes are not given proper protection from winds, the plants will become dwarfed and stunted; flowers are easily blown from the trees, and much loss may result from this. *Windbreaks should be planted before the lime plants themselves to ensure protection before the limes come into flower.*

As limes are essentially a low-country citrus variety, a suitable variety of windbreak tree should be chosen, for providing protection and at the same time collecting atmospheric nitrogen, such as *Gliricidia*. Two other plants which might be used instead are the Dadap (*Erythrina lithosperma*) or, for the higher elevations, the Acacia (*Acacia decurrens*).

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Where to get good Plants. Excellent three year old grafts of Tahitian Seedless Limes can be got from South Africa (Messrs. Pickstone & Bro., P. O. Simondium, Cape of Good Hope—Colombo Agents, Millers, Ltd.) These stand the drought and are well grown plants on Rough Lemon stocks. The Royal Botanic Gardens, Peradeniya, market an excellent Seedless Lime graft. Plants can also be got through The Hon. Secretary, Punjab P.C. Fruit Development Board, Punjab Agricultural College, Lyallpur, who recommend reliable nursery-men in India. The author has plants from the first two sources mentioned which are doing remarkably well.

Having obtained a nucleus of good plants the citriculturist will find it economical to do his own supplying. The propagation of limes can be carried out in a number of different ways, and this subject has been dealt with in a separate chapter.

Planting. Distance apart to plant.—This depends chiefly on three factors: (a) quality of the soil, (b) amount of rainfall, and (c) the lie of the land. If a minimum distance apart of 15 ft. by 15 ft. is taken and a maximum of 20 ft. by 20 ft., the grower won't go far wrong. The number of plants per acre at 15 ft. apart is 193, and at 20 ft. apart is 109. The holes should be of ample dimensions, as mentioned elsewhere for Oranges.

Artificial Manuring. (*See also Chapter IV.*) Like other varieties of citrus, Limes like **lime**, and when planting, a heavy application of lime is necessary as described elsewhere in this book.

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A yearly dressing of lime is absolutely necessary and should not be overlooked. **Potash** is also necessary if a good thin-skinned fruit is the cultivator's object.

The local villager supplies this by applying wood ashes which limes like ; this however is apt to cake in wet weather and should be dug in around the plant during the wetter periods of the year.

Mulches. (*See also page 22.*) A good mulch and top dressing over the root spread is essential. In the lower elevations, a leguminous cover crop which is dug in just after flowering may be a good idea; in drought areas, however, this is doubtful practice as the cover crop starves the plant of the valuable soil moisture. Remember that all plant food is absorbed in solution.

Surface Root System of Lime Tree. The Lime possesses a very extensive surface root system, and too frequent disturbances of the fine feeding roots near the surface of the ground results in deterioration of the trees. Don't hoe or fork too often or too deep.

Pruning. (*See also Chapter IX.*) As with other varieties of citrus, remove dead wood only.

Fungoid Diseases. Lime trees are subject to attacks of several diseases of a fungoid nature. The evidence appears to indicate that generally where soil in lime plantations is suitable in every respect for lime cultivation, root diseases of all

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kinds are reduced to a minimum. This suitability depends on (a) the nature and texture of the soil, (b) free drainage, and (c) the condition of vigour which is maintained by judicious manuring and fertilization.

Precautions. Careful attention to details connected with pruning, the tarring of cuts, protection of all exposed surfaces, would largely reduce the amount of rotting wood and consequently the incidence of fungi in the Lime plantation.

Other Diseases and Pests affecting limes and citrus generally are dealt with in Chapters VI and VII.

Cropping and Yield. A well established Lime plantation under favourable conditions produces one principal crop annually, but there are generally small quantities of fruit to be collected all the year round. The fruit as a rule take four to five months to mature from flowering stage to ripening. Recent investigations indicate that the average length of time for the ordinary Lime to ripen its fruit from the dropping of the petals to the time the fruit is ready to drop (dead ripe) is $16\frac{1}{2}$ weeks, the spineless variety $19\frac{1}{2}$ weeks.

The yield averages 150 to 160 barrels of fruit per acre. A barrel may be taken to contain 4.55 cubic feet or 3.55 bushels. The weight of a barrel of fruit varies with the character of the fruit and may be taken at approximately 160 lbs. Juice per barrel of fruit averages $7\frac{1}{2}$ to 8 gallons; this varies with weather conditions. The greater the rainfall the less the acidity of the fruit and vice

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versa. The greater the volume of juice, the less the acidity, and the reverse is the case with a low juice content of fruit.

Under favourable conditions, trees may yield a few fruit in the third year after planting — (West Indian experience). In the East the Seedless Tahitian Lime yields large crops of big fruit after $2\frac{1}{2}$ years.

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CHAPTER TWELVE

The Selection and Propagation of Limes

Much useful research has been conducted in Jamaica with a view to developing a type of lime suited to the rapidly growing markets in U.S.A. and the United Kingdom. A large-sized fruit is the desideratum. Established trees cannot reasonably be expected to produce the type of fruit needed, so research is concentrated on the discovery of new types.

Until recently, the lime has been entirely a wild tree crop running to a good deal of variety, so that standardisation of type is at best only beginning. Propagation was effected by the indiscriminate scattering of seed with this advantage at least, that unlike most tree crops, citrus species produce a high proportion of seedlings true to type; on the other hand citrus trees run to bud mutations or 'sports,' most of inferior quality, though the Washington Navel arose in this way.

The Selection of Limes for Propagation

The points to bear in mind when selecting limes for propagation are:—

(1) **Size of fruit.**—Large-sized, good quality fruit.

(2) **Shape of fruit.**—Roundish bell-shaped, the widest section of the fruit situated towards the apex rather than in the centre.

PROPAGATION OF LIMES

(3) **Quality of fruit.**—Thin, smooth skin, plenty of juice of good flavour, few seeds and a rich, deep green colour.

(4) **Freedom from disease.**—Freedom from fungoid diseases is especially desirable. See pages 11, 42 and 44.

(5) **Sparsity of spines.**—The less and the shorter the spines the better, as pricks or scratches on the fruit allow for the entry of fruit-rotting organisms.

(6) **Shape of tree and vigour.**—Choose vigorous and relatively upright trees.

Methods of Propagation

(A.) **By seed.**—The simplest and commonest method, and there is no reason why it should not be effective. After collecting the seeds from ripe fruits off the selected parent tree or trees, the usual citrus nursery practice of seed-bed and nursery rows should be followed. Care should be taken to eliminate all sexually produced seedlings, *i.e.* seedlings resulting from pollination and fertilization. These and all other seedlings abnormal in size, growth or character should be discarded—they may be as many as 25% of the seedlings planted. Uniformity of type has thus a better chance of being realised.

(B.) **By budding.**—The standard rootstock for cultivated citrus trees is the gummosis-resistant sour orange (*Citrus Aurantium*), though under certain circumstances (*e.g.* under certain

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climatic and soil conditions and with certain scion varieties) species such as rough lemon (*C. Limonia*), sweet orange (*C. Sinensis*), and trifoliate orange (*Poncirus trifoliata*), have to be used instead.

Caution.—As regards **sour orange** as a rootstock for limes it is well to note that :—

(a) It is too early yet to state definitely whether the combination is likely to produce a healthy, long-lived tree.

(b) In California lemons so raised in many cases stopped growing prematurely, collapsed and died suddenly.

(c) There is apparently a tendency for some lime trees to snap off from the stock at the point of union during windy periods.

Using lime as rootstock would not seem to offer any advantage over propagation by seed. If, however, recourse is had to bud-grafting, the same care should be taken about the selection of budwood as about the selection of parent trees for seed.

(C.) **By semi-hardwood cuttings.**—We are here again at an experimental stage and it is too early yet to pronounce with any definiteness. The method has these advantages :—

(a) Suitable wood is at hand nearly all the year.

(b) Cuttings form trees somewhat more rapidly than do seeds.

PROPAGATION OF LIMES

(c) Seedless or almost seedless types can be included.

The procedure outlined below would seem best suited for mid- or up-country Ceylon.

The **Requisites** for propagation by cuttings are :—

(1) **A propagator.**—The best type consists of concrete walls with a glass frame cover. A useful substitute would be an old packing-case with a cover of 'windowlite' (a form of cellophane with fine mesh wire embedded). The cover should fit as closely as possible to produce high atmospheric humidity inside the propagator. High temperature is also desirable but the cuttings should be saved from scorching by two or three layers of cheese-cloth placed over the glass.

The bottom of the propagator may be filled with gravel of any type or coarse sand to give proper drainage—a fine, sharp, calcareous sand similar to that found on many beaches, but free from salt, should do quite well if mixed with a little leaf-mould or red soil, 3 to 4 parts sand to 1 part leaf-mould.

(2) **The cuttings,** 4 to 8 inches long, should consist of terminal flushes that have recently ceased to elongate and that bear full-sized firm leaves up to the apex. Immediately before planting in the frame each cutting is pared back with a sharp knife to give a diagonal cut just below the base of a leaf-stalk; none of the leaves need be removed or cut in half.

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(3) **Watering** twice a day. Given the right conditions, rooting should start in 2 to 3 weeks.

Some 5 or 6 weeks after rooting has begun they may be planted out and shaded for a few days. After that they may be fully exposed to the sun. Judiciously watered, shoot-growth should start within a few days, and trees large enough to transplant into the grove should be obtained in the space of 3 to 4 months.

Note:— We are indebted to a particularly useful article by G. K. Argles in the Journal of the Jamaican Agricultural Society, October, 1938, for the substance of these notes. We have pleasure in acknowledging our indebtedness.

(D.) **By layering.** This is a method which the author has practised with considerable success on the Tahitian or Seedless Lime. It is an easier method than the usual budding on a rough lemon stock.

Method.—Take the low growing small branches of the Lime tree and peg them down, being careful to ring-bark the layered branch where it is buried, say two or three inches under the soil; it is at this point, where *callus* forms, that most of the young roots will develop. The layers should be strongly pegged down to keep them firmly fixed under the soil until such time as the young roots develop when they can be severed from the parent tree and planted out. It is possible thus to get say four or five layers per tree, and they seldom fail to root when the operation is properly carried out.

PROPAGATION OF LIMES

Layering should be done during the wet weather and the ringing of the bark thoroughly carried out, a narrow strip of about an eighth of an inch removed all round the layer. The section of a suitable size branch to layer should preferably be about the thickness of a lead pencil. Allow four or five inches of the end of the layered branch to stick out of the soil and do not remove the foliage from this. The leaves should be carefully stripped from that portion which is buried, being careful not to damage the axils of the leaves where young roots will develop.

Importance of Organic matter. The more humus the soil contains the better will be the roots developed, but efficient drainage should be provided. From land deficient in humus the young plants will be poor and unhealthy. In a nursery there is nothing that can take the place of an abundance of humus; if the young plants are forced too much with heavy dressings of artificial manure, they will not plant out so well.

TROPICAL CITRUS CULTURE

CHAPTER THIRTEEN

Ethylene Ripening

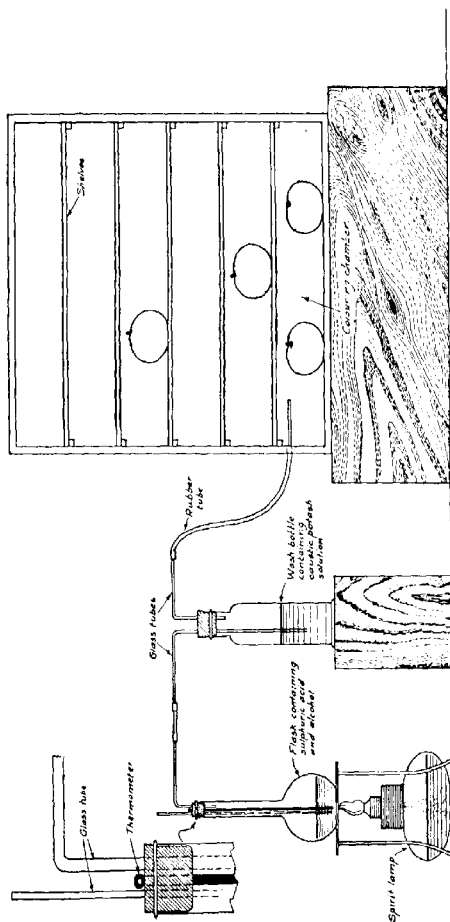
The ancient Chinese ripened hard pears from their orchards in rooms filled with burning Incense. Of course they did not realise why the fruit quickly became soft and luscious but they pointed the way to modern research. For a number of years it has been known that matured green fruit could be coloured and ripened by exposure to the fumes of a Kerosene stove. Finally, the active agent in these vapours was isolated in 1923 by an American Professor and it was found that the identity of the gas which caused the remarkable effect was Ethylene.

New Profits in Quick Ripening Process. Purchasers of fruit and vegetables pay more for appearance than for any other quality. The speed of the ethylene process saves handling, storage space and spoilage, as only a fraction of the time required with the older method of exposure to heat and sunlight is necessary.

Ethylene speeds the natural colouring process - it destroys the green pigment (Chlorophyll) in unripe fruit and vegetables. This permits the natural colour to appear; thus the green tomato turns red all over, and the green banana yellow, and the housewife in the market is attracted to the perfect specimens produced.

Ethylene destroys by oxidation the bitter element in unripe fruit (Tannin) which is so objec-

ETHYLENE RIPENING APPARATUS



- NOTES :- (1) The Corks used in the Flask and the Wash Bottle must be RUBBER CORKS.
 (2) The Colouring Chamber is a cupboard (3' x 3' x 3') with a close-fitting door or removable side screwed tight by butterfly nuts to ensure a gas-tight joint (not shown in the illustration). The shelves have interstices between the boards to allow the gas to permeate the whole chamber.

ETHYLENE RIPENING

tionable. Usually the aroma is improved when the Tannin is eliminated. Ethylene increases the sugar content by speeding up the action of the enzymes which change starch into sugar. It often makes the artificially coloured product more palatable than that which is allowed to ripen naturally. Ethylene has no effect on the vitamin content; vitamins which increase with ageing continue to increase with the ethylene treatment; those which increase only by exposure to sunlight remain present in the same proportion; none of them are destroyed. The food value of fruit or vegetable is not reduced by the ethylene treatment. It is absolutely non-poisonous and leaves no taste or odour on the fruit it ripens. It has no ill effects on the human system. At the low concentrations used for ripening it has no anaesthetic effect whatever.

Ethylene treatment as recommended by the Department of Agriculture, Peradeniya. Fruits are carefully washed in tepid water and well dried; they are then placed in an airtight chamber to which ethylene gas in the proportion of one to a thousand of air is passed. Ethylene gas is made by heating a mixture of 20 parts of alcohol with 60 parts of strong sulphuric acid in a flask and heating to 160 degrees Centigrade. The gas must then be purified by passing through a strong solution of caustic potash.

The period of exposure to the Air. The treatment lasts eight to twelve hours at a time. At the end of each period of exposure the fruits are removed and the chamber well aired. After about an hour's airing the process can be repeated till the fruits are sufficiently coloured. The gas

TROPICAL CITRUS CULTURE

chamber should be kept at about 85% humidity ; this is effected by placing a soup plate full of water in it. The temperature should be between 65 and 75 degrees Fahrenheit.

The total period will vary with the nature and degree of maturity of the fruit. Generally speaking mature grapefruit and oranges can be coloured in three to four days.

Special conditions for Citrus fruit. Oranges colour best if kept at 70 degrees F. to 75 degrees F; above 80 degrees F. there is a danger of wilting. For lemons the best ripening temperature is 60 to 65 degrees F., humidity 85%. The fruit will continue to colour after removal from the chamber. Pears can be ripened in four to eight days ; these are normally picked green and allowed to ripen in storage. Good airing is essential in their case.

JUICING

CHAPTER FOURTEEN

The Preparation and Bottling of Citrus Juices

The Local Department of Agriculture has published several pamphlets on local preservation of fruit juices, excellent, straightforward, well-written literature which leaves no doubt in one's mind that there is much to be learned on the subject. This literature however goes to show that the canning of local fruits is not the success that it is in other countries, though juices appear to have a ready market if prepared under strictly sterile conditions and filtered or centrifuged to render them clear and sparkling.

The knowledge of the essential constituents of citrus juices, of the vitamins and chemical contents to be preserved, and of how to keep these the same as when actually extracted from the fresh fruit, is the ideal aimed at. Analysis shows that partial success can be achieved in this line, and the determination of the vitamin contents proves that their presence can be truthfully assured to the buyer of preserved bottled fruit juice. It must be noted however that the vitamin contents suffer from the excessive removal of all pulp and perhaps pectins from the juices treated. Further, the samples of fruit would appear to benefit by being treated so as to get them evenly ripe. Uniformity of colour and maturity is, in the writer's opinion, necessary before the manufacture of citrus juice.

TROPICAL CITRUS CULTURE

Experiments with fruit juices other than citrus in the matter of bottling, preservation and keeping qualities, bring light to bear on the problems of citrus juices.

The manufacture of acid fruit juice products such as Cider, made from apples, has been the subject of much research and successful treatment. It must here be stressed again that, outside the manufacture of fruit juice products in Europe of so-called Lime and Lemon cordials and squashes by large commercial concerns, the layman places his knowledge on personal experiment, but it must be understood that no synthetic product can compare with the natural juices extracted from fresh fruits.

The admixture of sugar appears to be a general practice, and the pasteurization or other method of sterilizing the containers and their contents plays no small part in juice production.

Flavour. This must be the producer's first aim ; to preserve it and bring it out in the finished article. Unless the fruit is thoroughly ripe, some of the flavour is lost. Secondly, no unsound fruit of any description should be dealt with, if a superior juice is required which is to be genuinely wholesome and palatable.

The idea of using bruised and damaged fruit for juicing purposes is a fallacy which must soon disappear locally. A pure food certificate should be insisted upon by the buyer, and it will well pay the maker of juices to affix a copy of this to his containers.

JUICING

Labels. Next come the Labels: these should be attractive and well designed and last but not least, well printed and turned out. They had better be varnished to give a good waterproof finish.

Crown Corks. Crown corks are now almost universal for packing fruit juice. They give seal to the containers, unobtainable with the ordinary stopper which deteriorates the longer it is kept and affects the taste of the contents.

Plant. The plant depends on the output required and the quantity to be dealt with. It should include (a) an efficient system of filtration, (b) a deaerator flask and means of quick pasteurization, (c) bottling under semi-vacuum or other conditions where air contamination can be eliminated. All handling of fruit should be done by the staff with rubber gloves. The ethylene process has already been described as a means of the even ripeness, colour and maturity of the fruit being secured. A centrifuging machine tends to quicken the process and produce better results, but a sparkling juice cannot be expected as the result of its use. Messrs. Alpha Laval, the makers of cream separators, make a machine for the purpose.

Washing and sterilization of bottles and/or containers. Messrs. Lumley & Co., The Minories, London E.C., market a cheap bottle-washing brush which is mechanically driven and screws on to the side of a tub. They also produce many types of bottling and labelling machines and a cheap crown corker adjustable to the size

TROPICAL CITRUS CULTURE

of the bottles being dealt with. The address is given as the writer had much difficulty in the first instance in getting into touch with makers of such machinery obtainable at reasonable prices. They turn out a corking and capsuling machine both of which are essential.

Steam-jacketed, stainless steel containers are expensive items but none the less essential for juice work. They are more handy to use when ordered to tip. This eliminates sterilizing stop cocks and their components. To prevent burning, an electric agitator with its own small motor should not be overlooked when installing such plant.

Buildings used for juice manufacture should preferably be tiled to ensure easy cleaning and curved corners are more easily got at than angular ones. Shallow tiled, easily washable gutters should be allowed for. Ample lighting is essential and iron casements are recommended for buildings where juice work is carried out. Ceilings of asbestos or other such material are to be preferred to ceiling boards. Tables or benches insulated from ants which appear in the most miraculous way when juice work is being done, especially after sugar is added, are recommended.

Reamers to deal with citrus and other fruits can be obtained locally from the Manager of the Colonial Motor Works, who has designed and made such plant of excellent quality at less than half the cost of imported models. An orange cutter can also be got from this source.

JUICING

All containers should be of aluminium or stainless steel; measures in aluminium can be got from Messrs. Hunter & Co., as also good weighing machinery. Monel metal sieves and utensils are obtainable from Messrs. Harrisons & Crosfield, who are also the Agents for all Lister products.

India. The Fruit Juice Industry in India, especially so far as Citrus is concerned, is much more fully developed than elsewhere in the East. There are a number of well known reliable firms such as Gardener's Juices (India), Lyallpur, who supply juicing plant and factory equipment for juice work.

Reference : *Fruit Juices & Related Products* by V. L. S. Charley, B.Sc. (Hons.) Bristol, and H. J. Harrison, D.Sc. Agricul., (Sydney) & D.I.C. (Lond.)

TROPICAL CITRUS CULTURE

CHAPTER FIFTEEN

The Dietetic Value of Citrus Fruits

1. There are very few cases of Vitamin C deficiency in Ceylon because of the daily use of Lime juice to flavour curries. (Nicholls). People use lime juice in preference to tamarind, vinegar, etc. During certain seasons limes become very scarce and people buy a single lime even in thrifty Jaffna for 2 and 3 cents.

2. The value of lemons and limes in preventing scurvy is perhaps the best known fact known about vitamins for centuries. Capt. Lind, a British naval surgeon, published a book *Treatise on Scurvy* in 1757. In this book he mentioned the value of lemon juice in preventing scurvy. In 1804 the daily use of lemon juice in the British navy was enforced. The Board of Trade adopted similar regulations in 1865. The custom of issuing a ration of lemon or lime juice made the Americans nickname British seamen "Limies."

NAME	Moisture per cent.	Protein % per oz.	Carbohydrate % per oz.	Fat %	Ash	Calories 100gr. per oz.	Calcium (Ca) %	Phosphorus %	Iron (Fe) %	Vitamin A values	Vitamin B1 values	Vitamin B2 values	Vitamin C values
1. Orange	88	.8	10/3	.2	.5	45/12	.04	.03	1	x	x	x	xx
2. Grapefruit	88	.6	10/2.8	.1	.3	44/12	.02	.02	vl	vl	x	x	xx
3. Lemon	88	1.0	8/2	.7	.4	40/11	.05	.02	2	xx
4. Lime	88	1.0	9/3	.1	.6	42/11	.07	.02	vl	x	xx

xx good or very good source of vitamin
x moderate source of vitamin
1 little
vl very little
.. data inadequate



LEMON FRUIT

Genoa Variety imported South African graft on rough lemon stock
planted November, 1938

*(Photographed May, 1941
Tava Genoa Farm)*

DIETETIC VALUE OF CITRUS

According to this Table, lemon, lime, grapefruit and orange are good sources of vitamin C, the Antiscorbutic vitamin.

3. The Table also shows that oranges and grapefruit are sources of vitamins A, B1, and B2. Few other fruits have these vitamins.

4. Fruits are necessary in the daily diet for a supply of vitamins and mineral salts. Citrus fruits supply the necessary minerals in the form of Iron, Calcium and Phosphorus. (See Table.)

5. Citrus fruits are also valuable for times of illness. The orange is the safest of all fruits and may be given in diseases like coughs, dyspepsia, diabetes and heart disease.

Lime juice is used in cases of gout, rheumatism, neuralgia: when taken on an empty stomach citrus fruits, especially the grapefruit, are useful and have a beneficial action on the bowels. The juice of these fruits has a pleasant effect upon a dry throat. A Brazilian proverb says: "*A Naranja e oura na manhaa, nó meiodia prata e na noite mata.*" (The orange is golden at breakfast, silver at dinner, and deadly at night). The acids present in orange are:

1.93% free citric acid and malic acid,
1.39% of potassium citrate,
.25% of calcium citrate.

Everyone is familiar with the popular advertisement concerning Lime Juice and the hangover. That lemon juice has a biologic value is seen in the experiment conducted by Darwin. Monkeys which had been made drunk on alcohol the previous day, rejected food and selected only lemons!

TROPICAL CITRUS CULTURE

The following analyses have been obtained from papers published in *The Tropical Agriculturist* by the Chemist of the Department of Agriculture, Ceylon, and his Assistants.

Average Composition of Citrus Fruit

	Oranges		Grapefruit		Lime
	Local	Imported	Local	Imported	Local
Edible portion (per cent.)	53.0	-	55.0	-	55.0
Juice (per cent.)	45.4	49.9	43.5	40.1	49.5
Total solids (gm. per 100 ml.)	10.7	10.9	8.6	9.6	10.3
Citric acid (gm. per 100 ml.)	0.79	0.97	1.39	1.63	7.5
Ml. N/10 soda per 10 ml.	11.1	12.3	19.6	23.5	-
Total solids/acid ratio	15.1	13.3	6.5	6.1	-
Total sugars (gm. per 100 ml.)	7.28	7.42	5.07	5.37	-
Sucrose (gm. per 100 ml.)	4.32	3.97	2.14	2.04	-
Reducing sugars (gm. per 100 ml.)	2.95	3.57	2.92	3.33	-
pH	4.1	3.9	3.6	3.4	-
Vitamin C (mgm. per 100 ml.)	49.6	52.3	39.6	36.7	31
Sugar/acid ratio	10.3	9.3	4.0	3.5	-
Calcium (mgm. per 100 gm. pulp)	37.0	-	20.4	-	18.8
Phosphorus (mgm. per 100 gm. pulp)	18.7	-	12.5	-	16.1

mgm. = milligram

ml. = millilitre or cubic centimetre

N/10 soda is a decinormal solution of Caustic Soda

DIETETIC VALUE OF CITRUS

It will be noted that oranges have more calcium and phosphoric acid and vitamin C than either grapefruit or limes. The authors state that "local samples of oranges and grapefruit compare very favourably in analytical composition with the fruit grown elsewhere. In other respects, however, there are striking differences between local and imported oranges. Many of the local orange samples are inferior to the imported fruit in such characteristics as colour and looseness of rind, facility of peeling, character of rag, seedlessness, etc. These defects are probably the effects of the warm, continuously humid climate, and are less marked in local fruit grown in the cooler dry districts *e.g.* Welimada. Most samples of local grapefruit, on the other hand, are in every respect of the standard of, and some even superior to, the fruit imported into the Island. When the colour is lacking, artificial colouration can easily be resorted to with excellent results."

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TROPICAL CITRUS CULTURE

CHAPTER SIXTEEN

Citrus and National Development- Marketing

Eat more Fruit. We hear much today about pre-natal hygiene and nourishment, about taking the expectant mother in hand to produce healthy off-spring, yet very little is being done for the children from the time they come into the world. Go to any school and watch the tiny tots with their highly intelligent features and delicate frames.

One reason for this is unquestionably that the children do not get enough of the vitamins available in plenty from the fruitful Ceylon soil. As has been shown the vitamin contents of citrus are amazing and will help our youngsters to put up an effective resistance to so many maladies. It is too late in the day now for anybody to question the vital importance of vitamin content in food. The vitamin content of citrus has been quoted in the previous chapter.

Calcium. We are convinced moreover that to build up sturdy frames for our youngsters, calcium is *the* desideratum, particularly so here in Ceylon. The absence of calcium in the diet of the people is responsible in large part – it is not maintained that this is the sole cause – for the lower reserves of strength in the case of so many under-sized and under-nourished villagers, as well as for the apathy so often commented on. It would prove

CITRUS AND THE RACE

an interesting and enlightening study if statistics for the country could be compiled on the basis of the calcium content in the normal diet of the different districts. It would not surprise the writer if one conclusion was that our friends in the North of the Island had reason to be grateful for their limestone subsoil, even for their brackish drinking water!

To ensure the regular calcium content in diet, it is now the custom in many countries, notably in America, for all to take citrus daily. This and not any Nordic theory or practice is one of the great secrets for vibrant youth and manhood. Citrus contains in an assimilable form a considerable amount of calcium.

This is then the first point to be stressed, *to make the country citrus-minded in its own best interests.*

The citrus producer and government. In most other citrus producing countries, local commercial undertakings work with the producer and receive help and support from the governments concerned. If markets do not already exist, they are created.

Ceylon is one of the most fertile countries in the world but the marketing problem is still to be solved. One day the market is flooded with fruit and prices are unduly low, the next day very little fruit is obtainable and absurd prices are paid in many cases for inferior products. Until such time as our own marketing system is rationalized we must confine our attention to turning out citrus juice with the essential flavour and vitamin content of the fresh fruit intact.

TROPICAL CITRUS CULTURE

"Of the fresh fruit," be it noted, for every doctor will recommend every time the diet that is freshly killed or produced as against the frozen or synthetic product marketed to catch the eye.

PASSION FRUIT CULTURE

CHAPTER SEVENTEEN

Passion Fruit Culture - Preparation of Passion Fruit Juice

This section is being introduced for two reasons :
(1) To complete the hints given in our first edition even though we are quite well aware that such a section is not *de rigueur* in a manual like the present.
(2) To derive the fullest benefit from what is admittedly a side-line to citriculture as such but which, as experience is definitely proving, can be a most lucrative and successful line in itself.

Passion fruit juice, under various proprietary names, is a very hot favourite with the public. I am indebted to E. McCarry, Esq., of Hill Crest, Lisarow, N.S.W., for the practical hints I am now about to give.

Preparation. Prepare the beds two to three months before planting.

(1) Deep fork the soil and let it lie in the rough for say four to six weeks.

(2) The next stage is to break up the soil to secure a fine tilth. Add a heavy dressing of lime.

(3) A month later spread a depth of four to six inches of some really rich compost.

Planting.

(1) Run the rows as far as possible north-east and south-west so that the sun may get at each side of the plants.

TROPICAL CITRUS CULTURE

(2) Space the plants eight to ten feet apart in rows. Each plant should be in a hole two feet square, filled with 25% cow manure well rotted and 75% compost.

Treatment of Young Plants.

(1) After planting, watering by hand will be necessary, but such watering will obviously be determined by weather conditions.

(2) Allow for posts, eight to ten feet apart, five and a half feet above ground and about two feet underground. Between these posts stretch a heavy wire (about eight gauge) for the vines to run on.

(3) Rub off the side shoots until the leaders reach the wire when one should be trained in each direction.

(4) A light dressing of sulphate of ammonia, spread in a two-foot circle from the plant when it is eighteen inches to two feet high, will secure strong and early growth. Two to three ounces per plant will suffice. If there is a steady rainfall, the ammonia should be mulched to prevent its being washed away before the plants can benefit by it.

(5) Be careful not to cultivate too deeply: movement of the soil to a depth of two or three inches is sufficient. Deep cultivation injures the roots and the resulting injury causes a hardening of the fruit known in N.S.W. as *the bullet condition*. This is a hard, leathery condition of the skin, leading to the drying of the fruit and its being rendered unsaleable.

PASSION FRUIT JUICE

(6) Watch out for **brown spot** which in appearance is not unlike canker on citrus. It is due to prolonged lack of sufficient moisture and causes premature fruit-fall. If detected in time its incidence can be checked by a spray of permanganate of potassium. The spray must be a weak solution of say five grains to twenty gallons of water, *i.e.* a slightly coloured solution. Spray every ten days but not during the heat of the day.

Care of the full grown plant. Two heavy dressings of well-rotted Farm Yard Manure are required every year for the successful growth of the plant. The dressing had better be applied just before the vines flower. Between-whiles a little sulphate of ammonia will serve as an excellent tonic.

A successful vine will yield two heavy crops per year: each crop lasts two to three months.

Preparation of Passion Fruit Juice

Pick the fruit before they are dead-ripe, to ensure correct acidity. You will get more juice by so doing.

Wash them in warm water before cutting in half, prior to reaming or extraction of the pulp.

Use aluminium or other non-corroding vessels for juice work.

Use a juicer or wooden implement to press the juice through a screen which should be made of Monel metal or aluminium to prevent corrosion.

TROPICAL CITRUS CULTURE

Measure the juice and having strained it through a cloth, add sugar to taste — the usual amount required is approximately one lb. of sugar per pint. See that the sugar is properly dissolved.

Sterilize your bottles; see they are quite clean and no dust particles inside. To exclude these keep the bottles closed with a cork loosely inserted. See that the cork is boiled even for this, otherwise you will undo the care taken in sterilization.

Bottle the juice. If a funnel is used, a glass one is preferable; see that this is sterilized before use.

Preservative. Add 1/10th oz. of Potassium Metabisulphite per gallon; this proportion complies with the Food and Drugs Act. Use a good brand of chemical. "Analar Brand" is recommended as reliable.

Wash all bottles properly before labelling. Use an attractive label. See that your product is properly described thereon so as to comply with the law.

A catchy label will help to sell your juice, so see that it is attractive and well printed and turned out. All labels should be varnished by the printer, and made to fit the bottles they are put on.

Lastly, **pack your juice** properly so that it arrives at its destination looking well and intact. Go to a big firm for your chemicals, labels, etc. It pays to do so.

ROOTSTOCKS, SCIONS & BUDWOOD

CHAPTER EIGHTEEN

Rootstocks, Scions and Budwood

The commercial propagation of Citrus is by budding, although local practice prefers seedlings on account of the ease with which they can be raised. Seedling trees, however, have an erect habit of growth which makes spraying and harvesting difficult; they take longer to come into bearing and may not always breed true to type.

Rootstocks. Much depends on the choice of a suitable rootstock for success in raising a healthy plant. A good rootstock must possess certain known characteristics :—

- (1) it must make a good physical union with the scion and be compatible with it ;
- (2) it should be resistant to disease.

The two most popular rootstocks are the **Rough Lemon** and the **Sour Orange**.

The **Rough Lemon** (*Citrus Limonia*) is compatible with most varieties of Citrus, and being drought-resistant is eminently suitable for use on light sandy or gravelly soils. It has a shallow root system with a fibrous root spread which forages over a wide area; it is the best stock for Lemons and Limes.

The Rough Lemon is usually used for Grapefruit. It may be noted that the fruit borne on trees for

TROPICAL CITRUS CULTURE

which Rough Lemon has been used as a stock is frequently too large and coarse and lacks flavour. This tendency is apt to disappear after a period of five to six years, and is apparently due to the vigorous habit of growth of the Rough Lemon being passed on to the scion during its early life.

The **Sour Orange** (*Citrus Aurantium*) is highly resistant to gummosis, and for that reason is the best stock for use in wet soils which favour the incidence of root diseases. It has abundant and deeply penetrating roots; nevertheless it is not a stock that can be recommended for general use as it is somewhat variable in its adaptability to local conditions. On patna soils under semi-dry conditions, its growth is not so good as that of the Rough Lemon. It has been known to be a failure as a rootstock in South Africa where the Rough Lemon is used almost exclusively as a stock for all varieties of Citrus. The Tahitian or Seedless Lime scion is not compatible with Sour Orange for a stock. (See "Caution" on page 62).

The **Mandarin** has been used as a stock for citrus in Florida on an experimental scale. It is highly resistant to Citrus Canker which makes its use as a stock highly desirable in canker-infected areas. Semi-dry areas of mid-elevation (2,000 to 4,000 feet) appear to suit the Mandarin Orange.

The **Patharan** does well on very poor soils, is partial to dry situations and likes patna land. The biggest objection against it is its liability to develop Citrus Canker to which it is particularly prone. It feeds its scion well and appears to suit the Washington Navel. Some of our best Navel Oranges are on Patharan stocks. Long-lived

ROOTSTOCKS, SCIONS & BUDWOOD

stocks should be chosen. Hasty conclusions, however, should not be drawn from stock trials as some stocks may appear to be suitable in the beginning and begin to fail after a period of ten years or so.

(We are indebted to Mr. A. V. Richards, M.Sc. California, the Ceylon Government Horticultural Expert, for the bulk of the foregoing notes on Stocks and Scions.)

Notes on Taking Budwood

In a practical manual such as ours aims at being, we are leaving the highly controversial subject of the methods of budgrafting to experts, and would merely point out that a good tape for binding the budded plant goes a long way towards ensuring a better number of buds that 'take.' The tape should be kept in a closed tin and not allowed to get dried up before use.

Selection of Suitable Budwood.

(1) Robust healthy trees should be chosen so that diseases such as scaly bark and collar rot may not be transmitted to the future tree owing to infected budwood.

(2) The tree chosen should be a good bearer also, as obviously it will not pay to propagate from a 'lazy' tree.

(3) Sound branches supply the best budwood, especially those with green wood with white streaks from the previous season's growth, as young wood if tender will not 'take.' Angular budwood does not contain as much food as the plump young branch.

TROPICAL CITRUS CULTURE

(4) When budwood is required for topworking, very large buds should be chosen.

(5) See that the buds are in no way bruised. All leaves should be cut off, leaving about a quarter of an inch or slightly less of petiole i.e. leafstalk.

Packing Budwood for Transport.

If budwood has to be sent any distance see that (i) it is not exposed to the sun whilst being gathered, and (ii) it is packed in damp moss and really well wrapped in greaseproof paper to ensure its arrival at its destination in a damp condition; thus you ensure against transpiration of the moisture in the wood.

Where large quantities of budwood are sent to other orchards, it is as well to wire the consignees to warn them of its despatch; for long distance travel, the packages might also be labelled "To be kept Damp." Wax the ends of the budwood.

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FRUIT DISEASES *by* MASSEE

FRUIT-FLY *by* DR. HUTSON *in* THE TROPICAL AGRICULTURIST

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THE ANALYSES OF THE MORE IMPORTANT FRUITS OF THE
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SEKERE, *in* THE TROPICAL AGRICULTURIST, VOL.
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THE CANNING AND BOTTLING OF LOCAL FRUIT AND THE
PRESERVATION OF FRUIT JUICES AND CORDIALS
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THE COMPOSITION OF LOCAL AND IMPORTED CITRUS FRUIT
by A. W. R. JOACHIM, PH.D., B.Sc. LOND., F.I.C., DIP.
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THE TROPICAL AGRICULTURIST, VOL. XCIII, No. 1,
JULY, 1939

THE CULTIVATION OF CITRUS WITH FURTHER SUGGESTIONS
FOR ITS IMPROVEMENT *by* T. H. PARSONS, F.L.S.,
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THE VITAMIN C CONTENTS OF SOME CEYLON FRUITS AND
VEGETABLES *by* A. W. R. JOACHIM, PH.D., B.Sc.
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